NATURE

No. 4066 SATURDAY, OCTOBER 4, 1947 Vol. 160

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Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London
Advertisements should be addressed to
G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone: Temple Bar 1942
Subscription rate is £4 10 0, payable in advance, Inland or Abroad

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Registered as a Newspaper at the General Post Office

NATIONAL PARKS

IN 1872 the first national park in the world, the Yellowstone National Park, was established by an Act of Congress, and it is still the most noted of all American national parks. It lies mainly in the State of Wyoming and is sixty-two miles long and fifty-four miles wide. The scenery in this park is of exceptional grandeur and beauty, and the park contains many natural features of outstanding interest—forests, alpine flora, a very varied terrestrial and aquatic fauna, more than a hundred geysers and four thousand hot springs, and the Grand Canyon of the Yellowstone. It can be no cause for wonder, therefore, that such a unique area should have been taken over for the enjoyment of all almost as soon as it was first surveyed. Since then, as stated by Dr. Herbert Smith in his article on "Nature Protection in Great Britain" (p. 457 of this issue), the idea of national parks has spread throughout the world and in many places been put into effect. Some, such as that in the Belgian Congo, are very extensive; others are comparatively small.

But national parks need not necessarily be confined to areas of exceptional merit or interest; moreover, as pointed out in Dr. Smith's article, the *raison d'être* of a national park is not simply public pleasure or scientific study; it must perform a multiple function. This casts our minds back to December 8, 1938, when the Linnean Society of London met to discuss the objects of national parks. The discussion arose from a letter sent by Prof. J. B. Cleland, chairman of the Commissioners of the National Park at Belair, South Australia, who asked the Society for a definition of a national park, and to express an opinion as to how far facilities for sport and recreation should be allowed to replace the original fauna and flora, especially when the park is near a thickly populated area.

At that Linnean Society discussion, Sir Peter Chalmers Mitchell claimed that a national park should be an area under public control where wild animal and plant life is preserved and hunting and collecting only allowed under licence; but he also agreed that it would be unreasonable to hand over smaller parks near towns for the exclusive use of naturalists. Dr. Julian Huxley maintained that, at any rate in Great Britain, within a national park, recreation, walking and camping in unspoilt countryside must take precedence over the preservation of flora and fauna. Dr. Herbert Smith himself suggested that the two main aims of national parks—scientific and recreational—are not incompatible. Other views expressed at that discussion tended to support the idea that, under intelligent control, a national park could be a sanctuary where plants and animals could thrive under natural conditions (though it must be borne in mind that these conditions are dynamic, not static), yet also afford facilities for recreation and sport even if these may have to be limited to certain well-defined areas within the park.

Apart from their multiple functions, national parks will vary, of course, according to their individual

characters. Though the Linnean Society's discussion was held nine years ago, the idea of the establishment of national parks in Britain has gained ground and several important reports have been published since. These are discussed by Dr. Herbert Smith in the article published in this issue.

It is well that in a small country such as Britain the conception of the form and function of national parks should be thoroughly discussed before any large-scale plans are formulated and then put into effect. As Dr. Smith points out, Britain has a beautiful landscape varying considerably in character; in fact, the variation itself is worthy of note. So to preserve this for posterity the establishment of national parks is essential. In the discussions and reports so far published, Nature preservation and respect for geological monuments loom large; but in the latest report, that of the National Parks Committee of the Ministry of Town and Country Planning recently published, it is emphasized that the function of national parks should be "more the spiritual and bodily refreshment of the people, especially the inhabitants of cities and towns, than the protection of wild life". Furthermore, considerable tact and caution are necessary when deciding what priority or privileges should be given to *bona fide* students of natural history over the general lay public. For example, complaint has already appeared in the newspaper press about the closing of Flatford Mill (immortalized by Constable) to the general public in favour of students. No matter what facts lie behind the acquisition of any monument, it is desirable that public opinion be taken into full consideration before final policy is settled, especially since it seems to be agreed that spiritual and bodily refreshment of the general public is of paramount importance. In other words, the authorities who have the final say in choosing and administering national parks should aim at preventing different interests from becoming clashing interests and so conflicting with each other. On the contrary, they should aim at utilizing such parks as places where not only may each interest be satisfied so far as is commensurate with the common weal, but also where one interest can meet the other to the benefit of both—a symbiosis of interests.

Thus might become established that nucleus of biological service, as Dr. Smith envisages and Dr. E. Hindle in his presidential address to Section D (Zoology) of the British Association meeting at Dundee this year pleaded for, which would offer the best field opportunities for the natural historian working among the lay public, who would conceivably watch his work with interest. Here would be an arena where work and play could move together hand in hand.

Difference in character must also be taken into account. A park in the Scottish Highlands would be unlike one in the Lake District, and again very different from one on the rolling downs of the south of England. This would need serious consideration when deciding on organisation and personnel for administration and control.

SCIENTIFIC AND TECHNICAL BOOKS

As one of the measures for reducing British expenditure in countries in the 'dollar area', it has been announced that restrictions are being imposed on the importation into Britain of books. At a time when emphasis is being placed increasingly on the importance of international understanding, it is most unfortunate that this particular medium should have been selected as a means of effecting economies; books are surely one of the best means of making one people acquainted with another. Here we are concerned mainly with scientific and technical books, and the restriction will in practice apply chiefly, though not entirely, to American books. The position is that scientific and technical books may no longer be imported except under individual licence. British publishers have to submit to the licensing authorities evidence of the value of their pre-war imports of such books, and they will be given a licence to import foreign books to the same annual value. Thus we return, at a stroke, to the maximum war-time restrictions. Publishers will now have to apply quarterly for licences to import specified quantities of named books, and giving in each case the name of the exporting country.

There are some observations on such a scheme which immediately come to mind. First there is the vexatious delay in obtaining a necessary book, should the British publisher have no copy in stock. Further, in imposing this form of individual licence, the Government is in effect instituting a system which might easily become a form of censorship. A more immediate objection is that the present scheme is based on money value, and takes no account of the increase in book production costs. So far as American books are concerned, prices are 50 per cent and more above the pre-war figure for corresponding books. In effect, therefore, the number of scientific and technical books of American origin it will be possible to import into Britain will be substantially less than the figure for 1939.

It is becoming generally accepted that the utmost efficiency is necessary in the scientific and technical fields to enable Britain to recover its position in the world. Yet by cutting down supplies of the essential books, the Government is putting an important obstacle in the path; and this at a time when there is an acute shortage of school and university text-books and also of standard works of reference. It may be urged that some American text-books are not suited for the courses in British schools and universities, but that argument cannot be applied to research monographs and reference works; these, with the all-important specialist periodicals, are essential tools for the scientific worker trying to keep abreast of modern developments.

While it must be granted that restrictions on general expenditure are necessary, it would seem that scientific and technical books should have a high priority in the permissible expenditure of dollars; and it should be possible to devise a scheme whereby such books are made more readily available.

DUTCH PIONEERS IN SCIENCE AND INDUSTRY

Nederlandsche Baanbrekers der Wetenschap Door J. C. Alders. Pp. 201. (Amsterdam: Bigot and Van Rossum N.V., n.d.) n.p.

THIS book contains excellent popular descriptions of the work of the Dutch pioneers of science and industry during the last fifty years. The sciences included in this book are astronomy, biology, chemistry and physics, and the industries agriculture, aviation, mineral oil, radio and tin. The book is really about the subjects mentioned, but it is arranged biographically. Of the many famous names mentioned, which include Nobel Prize winners, are the following: Kamerlingh Onnes, Van der Waals, Lorentz, Zeeman, Debye, de Vries, Fokker; and reference is made to the Philips laboratory at Eindhoven.

It was in 1895 that Zeeman discovered that in a plane parallel to an intense magnetic field each line of the spectrum of a sodium or lithium flame placed in the field became a doublet, whereas if the light was examined spectroscopically in a direction at right angles to the field, there was each ordinary line together with two components associated with it. When a spectroscope is pointed to the sun's centre, doublets are seen; whereas triplets appear if a sensitive spectroscope is directed at a point near the sun's periphery. Thus is demonstrated the sun's intense radial magnetic field. This work and other like it has led to the recent hypothesis of Blackett.

Van't Hoff was a pioneer in the mechanical theory of valency and in the connexion of the optical activity of many carbon compounds with their chemical constitution. The theorem known by his name connects the quantitative displacement of equilibrium with change of temperature, and he showed the analogy between dilute solutions and gases via their osmotic pressures.

De Vries was perhaps unlucky in his choice of the evening primrose (*Œnothera lamarckiana*) for his work on mutations in heredity and evolution, when he put forward his ideas of spurts or storms of mutation—because some of the changes from individual to individual have no evolutionary significance, since the supposedly new species and variations cannot breed true. The revived work of Mendel and later work on chromosomes have superseded the work of de Vries.

Vening Meinesz is particularly famous for gravity measurements at sea in a submarine. Between the years 1922 when the first test of Meinesz's two pendulums was carried out on S.S. *Paleleh* between Ymuiden and Flushing, and 1934 when he made a submarine trip via the Cape to the Dutch East Indies, Vening Meinesz was constantly engaged in improving his apparatus, testing it at sea, and working up the results obtained. During 1926–27 he undertook a voyage from Holland via Panama to Soerabaya, in 1929–30 to the Gulf of Mexico and to the Dutch East Indies, and in 1932 to the Azores and Cuba. In the Dutch East Indies, he made numerous gravity measurements and discovered an 'axis' where gravity is greater than expected, in some places by 65 milligalls. Next to this is a chain of gravity deficiencies, which chain runs through Sumatra, south of Java, across the Soenda Islands, through the Philippine Islands to Japan. This chain of approximately 100 km. width runs along with, or parallel to, the earthquake belt. In the Dutch East Indies volcanoes are on the landward side of the axis of Vening Meinesz. This axis is very significant in the realm of geophysics.

In the world of industry the Dutch have made great strides in our methods of working tin and oil; the work of Fokker in aeronautics and the laboratory of the Philips Co. are too well known to require enlarging upon here. Less well known, though no less important particularly at the present time, is the work of the Dutch Cultivation Co. and the Dutch potato flour industry.

From what has been described above it will be seen that this popularly written book will be of great value in putting before the general Dutch public and the world the contributions which her learned and industrious sons have made to Holland and the world, and will show that this is indeed great when one looks at the size and character of the countryside. The book is in Dutch, and the author of this notice is indebted to Mr. C. Knor for assistance with the translation.

ERNEST TILLOTSON

THE U.S. PHARMACOPŒIA

The Pharmacopœia of the United States of America (the United States Pharmacopœia) Thirteenth revision. By Authority of the United States Pharmacopœial Convention. Pp. cvii + 957. (Easton, Pa.: Mack Publishing Co., 1947.)

THE first United States Pharmacopœia appeared in 1820, and up to 1936 revisions appeared at intervals of about ten years. This interval has now been reduced to five years, owing to the rapid advance of therapeutics. The thirteenth revision (1947) is an impressive book containing more than a thousand pages, and much work has been put into its preparation. It is controlled by the U.S. Pharmacopœial Convention, which meets "upon the second Tuesday in May in the first year in each decade ending in zero". The number of delegates attending the convention in 1940 was 487, not counting guests from various neighbouring countries, of which Costa Rica, Cuba, Dominican Republic, Nicaragua, Panama and Uruguay have given official status to this Pharmacopœia. This convention elects a president, five vice-presidents, a secretary, an assistant secretary, a treasurer, a board of trustees and a general committee of revision consisting of sixty members. The board of trustees elects a director of pharmacopœial revision, and the general committee provides ten sub-committees, the chairmen of which constitute the executive committee of revision. These details and many more are given in the introductory pages of the Pharmacopœia.

The complex organism thus sketched is rich, partly because much of the work is unpaid and carried out from a sense of public duty. It is unfortunate that a good deal of it is duplicated in other countries in order to produce many other pharmacopœias suited to local conditions. The time is surely coming when an international pharmacopœia will be accepted all over the world. Some steps in this direction have been made; but progress is slow. An organisation such as the Americans have provided might produce a truly international pharmacopœia, though, unfortunately, most other countries are afraid of being swamped. The advantages of internationalization in this field are, however, so great that every effort should be made in this direction. One difficulty lies in the fact that the trend of therapeutic practice differs in different countries. It seems strange that the

Americans are at this moment removing 'Pamaquine' and chaulmoogra oil from their Pharmacopœia. They do not include leptazol, or nikethamide, or lobeline, and seem to rely on picrotoxin as the only official analeptic. They include no acridine antiseptic.

Another difficulty is the question of nomenclature. New pharmacopœias generally contain a few new names for old drugs and omit the old names, which are unsuitable for official use for one reason or another. Sometimes these new names explain themselves; benzalkonium is fairly obviously a cationic detergent. Sometimes their interpretation forms a test of general knowledge. Iodopyracet is the new American name for diodone, which is used to display the renal pelvis under X-rays. Some readers will no doubt be driven to other works of reference to confirm the fact that these two substances are, in fact, identical.

Some attempt is made to achieve agreement about such neologisms between the British and the Americans, but the results are disappointing. The Americans use 'f' where the British use 'ph', and simplify spelling in various other ways. The drugs known in America as epinephrine, menadione, tetracaine, quinacrine, and anhydrohydroxyprogesterone are known in Britain as adrenaline, menaphthone, amethocaine, mepacrine and ethisterone respectively.

The new work contains many admirable features. The official names have been chosen so as to bring allied preparations together in the alphabetical arrangement; for example, tincture of opium is called opium tincture, so that it comes near opium itself. Metric doses have precedence over avoirdupois; this convention will be welcomed internationally. English names have precedence over Latin names; this convention will be welcomed in English-speaking countries. There is much incidental information about the properties of a wide range of substances which are only occasionally used by pharmacists as reagents, and about the measurement of viscosity, *p*H, turbidity, melting points, optical relation, etc.

Methods of biological assay are described for such substances as epinephrine, posterior pituitary, insulin, vitamins A, B and D, and all preparations containing cardiac glycosides, and there are microbiological methods for nicotinamide and riboflavin. Such biological methods are not applied to pure active principles such as epinephrine or ouabain, but they are applied to preparations of these active principles, such as epinephrine solution or ouabain injection. In these cases, the assay is clearly not intended to be applied to each sample, but only used in cases of doubt or dispute. In the case of other drugs, such as insulin and digitalis tincture, the assay forms an integral part of the manufacture, and the exact procedure is prescribed in great detail, which leaves much less to the discretion of the individual than is the custom in Britain. Some of the details of the techniques will no doubt be criticized. Cats are to be used for the assay of digitalis, and methods using frogs are not recognized. There is no convincing evidence to justify this decision. Rabbits, and not mice, are to be used for the assay of insulin, and they must receive three doses of the unknown preparation and one dose of the standard, instead of two doses of each, as is customary here. The attempt to make these tests foolproof has made them too rigid.

The assays of various vitamins are not designed to measure their concentration, but only to ensure a certain minimum activity. This decision greatly simplifies the interpretation of the result. The standard preparations to be used for these assays are distributed officially; the Pharmacopœia seems to contain no information about their composition. It would be interesting to have been told whether the standard for vitamin D in cod liver oil is vitamin D_3, as it ideally should be, or calciferol.

For various reasons, some of which are mentioned above, this Pharmacopœia could not be officially adopted as it stands in Great Britain, but it contains much that we can admire, and might copy. The Americans are to be congratulated on a fine piece of work.

J. H. GADDUM

METHODS IN CELLULOSE CHEMISTRY

The Methods of Cellulose Chemistry

Including Methods for the Investigation of Substances associated with Cellulose in Plant Tissues. By Dr. Charles Dorée. Second edition, revised and enlarged. Pp. xii+543. (London: Chapman and Hall, Ltd., 1947). 42*s*. net.

THE earlier edition of this book has been of very great value to all whose interests have been in the field of cellulose chemistry, and there can be no doubt, therefore, of the welcome which will be accorded to a second edition. The full usefulness of the volume can be appreciated only when the complete title is considered, since the reader will find, in addition to the multifarious methods of investigation applicable to cellulose and its derivatives, concise accounts of the methods of attack which have been developed for investigations on lignin, hemi-celluloses and pectic materials.

Much has been added to our knowledge of all these substances in the course of the fifteen years which have elapsed since the first edition was published, and Dr. Dorée has now undertaken with conspicuous success the formidable task of incorporating new matter and revising the old. No fundamental changes have been found necessary, but a great deal of new material now finds its place in the book. In Part I methods used in the examination of normal cellulose are collected, including the measurement of physical properties, methods of analysis applicable to cellulose, mercerized cotton, rayons, hydrocelluloses and oxycelluloses. There is a chapter devoted to the investigation of damage in cotton and linen fabrics. The second part is concerned with synthetic derivatives of cellulose, including esters and others, and on this topic much new matter has been added in the present edition. The third part deals with the compound celluloses, and in addition to a chapter on the qualitative and quantitative examination of plant tissues there are detailed accounts of procedures for the estimation of cellulose and lignin, and of the standard methods for the estimation of furfural, uronic acid and methoxyl. Chapters are included also on the analysis of wood, and on the chemistry of lignin and the hemi-celluloses.

The book is designed for use by the practical worker in the laboratory. It is well illustrated with figures and graphs and is fully documented. Precise and detailed directions are given for all the analytical procedures. The comprehensive author- and subject-indexes facilitate reference, and the book has been excellently produced in a clear type which is a pleasure to read. Dr. Dorée is to be warmly congratulated on the appearance of this second edition of a most useful and valuable work.

E. L. HIRST

PEACEFUL APPLICATIONS OF NUCLEAR FISSION

A SYMPOSIUM on the "Peaceful Applications of Nuclear Fission" was arranged by Section A (Mathematics and Physics) at the recent meeting of the British Association at Dundee. It was opened by the president of the Section, Sir Edward Appleton, who said that no scientific subject had ever aroused quite the same mixture of hopes and fears. At that meeting they were to concentrate on the hopes; in due course the work conducted on the development of the atomic bomb would lead to the saving of far more lives than were lost in the attacks on Japan.

Dr. J. D. Cockcroft remarked that the peace-time applications of nuclear fission would result from the achievement of a divergent nuclear chain reaction in the atomic pile—first built by Prof. E. Fermi in the University of Chicago in 1942. The fission pile provides a much more powerful source of neutrons than the largest cyclotron. The pile would make possible new types of experiments in nuclear physics and would be the main source of radioactive isotopes. With the production of neutrons goes the development of heat, and the pile is a *potential* though not certain new source of power for the world.

The first objective of the Atomic Energy Research Establishment at Harwell, Berks, had been the construction of a low-power graphite pile known as "G.L.E.E.P." similar to that now in use at the Argonne National Laboratory in Chicago. This pile consists of several hundred tons of graphite bricks between which are grooves for the insertion of uranium metal and uranium oxide. Surrounding the pile is a shield of concrete about 5 ft. in thickness. This is required to reduce the intensity of the neutron and gamma radiation developed inside the pile to tolerance-levels. The shield is pierced with holes for control instruments, control rods, safety rods and for 'thermal columns' to bring neutrons of thermal energy out to the shield face for experiments.

The concrete shield and its accessories took about a year to build. Loading of the uranium started on August 5 and was completed by August 15 of this year. During the loading of the uranium the multiplication constant, k, of the pile increased towards unity, and since one neutron released in the spontaneous fission of a U238 nucleus leads to $1 + k + k^2$ or $1/(1 - k)$ neutrons, the course of approach to the critical or divergent state is followed by recording by a boron trifluoride-filled counter the flux of neutrons inside the pile. Thus on August 7, when 7 tons of uranium had been loaded, the counter recorded 17 neutrons per minute. By August 11 this had increased to 55 neutrons/minute, by the morning of August 15 to 2,400 and by early afternoon to 6,600 per minute. At this point the counter was saturated—the pile being almost divergent. During the last stages of loading, the control rods were partially inserted, reducing k slightly. Uranium was then loaded until the divergent point was just passed. At this stage the pile generated about 0·1 watt of thermal energy. The power-level increases exponentially with time but with a very long period. The period depends on $1/(k - 1)$, and with an excess of k of 1/40,000 the period is one hour. The pile is therefore very easy to control. A withdrawal of the control rods led to a decrease of the period to about a minute and the power-level was allowed to increase to 100 watts, at which level ionization chambers had been pre-set to release the shut-off rods and shut down the pile. The first objective of the Harwell work had, therefore, been realized in about fifteen months.

Measurements would now be carried out to determine all the pile characteristics. This was expected to take about one month. After that the power-level would be increased to a level set by the safe operating temperature of the uranium. In this pile only very simple cooling is used, and it would probably be necessary to limit the average power to about 50 kilowatts. At this power-level there would be a maximum thermal neutron flux of 10^{10} neutrons/sq.cm./sec.; the total number of neutrons generated would be about 3×10^{13} per sec., of which about one per cent could be used for production of radioactive isotopes or for experimental work. It was intended to start radioactive isotope production immediately. Some isotopes could be produced in adequate intensities by this pile—thus it is estimated that 5–10 curies per month of radiophosphorus could be produced monthly by the capture of neutrons in phosphorus. Production of high specific activity P^{32} by the (n,p) reaction in sulphur would be considerably smaller. Long-lived isotopes such as C^{14} could only be produced in small quantities, and adequate production would have to await the completion of the second Harwell pile.

One of the principal applications of the low-power pile is the study of the nuclear reactions of elements with slow neutrons. The introduction of as little as 0·1 mgm. of cadmium into the pile produces a detectable change of power-level; and from the rate of change, the absorption cross-section for slow neutrons can be determined. In practice, specimens under investigation are moved into and out of the pile with a period of 20 sec. or so and the amplitude of oscillation of the power-level measured by a resonant galvanometer or other suitable methods. A pile of this type is an indispensable tool for the control of nuclear properties of all basic materials used in the construction of piles.

The power-level of a pile can be increased by more intensive cooling of the uranium metal, and in the second Harwell pile the metal rods will be cooled by a high-speed stream of air flowing past the rods. In this way the power-level could be increased to several thousand kilowatts. The uranium metal would be sheathed with aluminium to prevent oxidation and escape of fission products. The decreasing creep strength of aluminium with increasing temperature would probably limit surface temperatures to about 350° C., and emergent gas temperatures would therefore be limited to about 300° C. Although this is not high enough for efficient power production, a heat exchanger would be placed in the emerging gas stream and some use made of the pile heat.

The emergent gas temperature could be increased if a material having more favourable properties could be substituted for aluminium. Metals such as steel would reduce the multiplication constant below unity; beryllium would be suitable if it could be produced in ductile form.

The second Harwell pile will be used to study problems of power production. Thus it is important to study the effect of neutron irradiation on the

physical properties of materials used in piles—it is known that some deterioration takes place. It is also important to study the effect of formation of fission products on the multiplication constant of the pile, and in particular the effect of the partial substitution of U235 by plutonium in the pile.

It is expected that the neutron flux and available neutrons will be of the order of a hundred times that available in the G.L.E.E.P. This would make possible the full production of most radioactive isotopes required in Britain. A few isotopes would be limited in quantity.

This pile would also provide a powerful source of fission products—which are distributed among the thirty-five elements from zinc to gadolinium. At 1,000 kW. power-level, about a gram a day of fission products would be produced.

Other types of pile important for scientific research include the heavy-water piles. These piles have a higher multiplication constant than the graphite pile, and would use a substantially smaller amount of uranium and moderator. For a fixed power output they could give a much higher neutron flux, and this is very important for some experiments and for the study of future developments. A high-power heavy-water pile has recently been completed at Chalk River by the Canadian National Research Council, and will provide an important experimental tool for atomic energy research.

The future of the application of nuclear fission to the large-scale development of power is at present obscured by lack of information on a number of essential points.

A pile using natural uranium sheathed by aluminium and cooled by a circulating gas could be used for steam generation and power production by a steam turbine. Experimental plants of this type would probably be built, though their thermodynamic efficiency would be low, due to the temperature limit of aluminium. If Nature were exceptionally kind, a plant of this kind containing 100 tons of uranium would generate 100,000 kW. of thermal energy for twenty years without fuel replacement. Actually, however, the formation of fission products will probably lead to poisoning of the chain reaction due to their additional absorption, and difficulties may be experienced due to deterioration of materials under the intense neutron bombardment of the pile. The metal will, therefore, have to be withdrawn at frequent intervals, the fission products extracted and the uranium and plutonium reprocessed. Until operating experience tells us how frequently this will have to be done, and what the costs will be, it is not possible to predict the costs of nuclear power. The position about reserves of nuclear fuel is equally uncertain at the present time, since the proportion of the uranium which can be used is unknown.

So far, piles have used only a fraction of the energy of U235. In the future, we may hope to do considerably better than this. As a pile burns up the primary fuel atoms of U235, the neutrons released in the fission can turn U238 into plutonium, which is fissionable by slow neutrons and is a secondary fuel just as good as U235. One U235 atom will in general be replaced by rather less than one plutonium atom; this in turn will be partially replaced. The overall result is that there is a possibility of utilizing more than the fission energy of U235. Ideally we might go a long way towards reaching the full utilization of U238—how far we can go we do not know.

There is also a possibility of utilizing the fission energy of thorium by turning it into U233, which is also fissionable by slow neutrons.

One other major uncertainty stands in the way. With nuclear power goes a very large-scale production of radioactive materials. A power plant generating the thermal energy of a million kilowatts produces daily an activity of the order of a million curies even after an appreciable decay is allowed for. A world run on nuclear power would generate at least a hundred times this activity. The safe disposal of these products presents a major problem.

Prof. O. R. Frisch described the application of the fission pile to nuclear research. A high-power pile of the type being built at Harwell would produce very large numbers of fast and slow neutrons. Experiments requiring fast neutrons continue to be carried out, for the most part, on cyclotrons, which provide a point source of fast neutrons, whereas the pile neutrons are spread out over several thousand cubic feet of pile volume. The pile has, however, a decisive advantage for experiments with slow neutrons, since the cyclotron source becomes diffuse in slowing down the neutrons. Experimental work was described using a mechanical velocity selector to study the velocity distribution of slow neutrons emerging from the pile. Filtering through graphite has been shown to reduce their mean velocity by a factor of 4 owing to their wave properties leading to selective transmission through the graphite lattice. This is due to the absence, for very slow neutrons, of lattice planes fulfilling the Bragg reflexion condition. On the other hand, homogeneous neutron beams can be obtained by Bragg reflexion from crystals, and the crystal spectrometer provides a powerful method of studying neutron-capture phenomena. It is expected also that neutron scattering from hydrogen atoms in crystals may result in neutron spectroscopy being a valuable tool for the organic chemist. Slow neutrons have been shown to be totally reflected at glancing angles; this proves that the refractive index of the materials used (glass, graphite, etc.) is less than unity for neutron waves. The intense beam of pile neutrons would make it worth while to look for the decay of the neutron into a proton and an electron.

Mr. W. G. Marley described the production of radioactive isotopes in a pile. The simplest procedure is to produce them by neutron capture, that is, by (n,γ) reactions. The materials to be irradiated are placed in the reflector of the pile, where up to one-fortieth of the pile neutrons can be absorbed for this purpose.

Some biological experiments require a high specific activity—500 millicuries per gram of materials. For this purpose it might be necessary to use (n,p) reactions, for example, in $S^{32}(n,p)P^{32}$. Many of these reactions require fast neutrons and can only be produced in the core of the pile, where the available neutrons will be only about one-tenth of those available in the reflector. A few isotopes such as tritium would be produced by (n,α) reactions. The high-power Harwell pile would be able to produce quantities of most isotopes more than adequate for all likely requirements. A few long-lived isotopes such as tritium, C14, Cl37, would be limited by pile capacity, though an annual production of 4–5 curies of C14 should be possible.

It is expected that a few radioactive isotopes, such as Na22, will still have to be produced in the cyclotron,

since they can only be produced by neutrons by $(n, 2n)$ reactions requiring very fast neutrons.

Radioactive isotopes produced by (n,p) reactions would require chemical separation; and when the processes have been established at the Harwell station, routine separation will be carried out by the Radiochemical Centre of the Ministry of Supply. The allocation of radioactive isotopes will be carried out by a sub-committee of the Advisory Council for the Radiochemical Centre. This sub-committee, under the chairmanship of Dr. J. D. Cockcroft, includes representatives of user interests—the Medical and Agricultural Research Councils and the Department of Scientific and Industrial Research, which will represent the universities and industry.

Radioactive isotopes from piles in the United States have been available to American users only since 1946, and a large number of applications to medical, biological and industrial research have already been found, while the future has been declared by Dr. G. Seaborg to hold unlimited possibilities.

J. D. Cockcroft

OBSERVATIONS ON THE TRACKS OF SLOW MESONS IN PHOTOGRAPHIC EMULSIONS*

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INTRODUCTION. In recent experiments, it has been shown that charged mesons, brought to rest in photographic emulsions, sometimes lead to the production of secondary mesons. We have now extended these observations by examining plates exposed in the Bolivian Andes at a height of 5,500 m., and have found, in all, forty examples of the process leading to the production of secondary mesons. In eleven of these, the secondary particle is brought to rest in the emulsion so that its range can be determined. In Part 1 of this article, the measurements made on these tracks are described, and it is shown that they provide evidence for the existence of mesons of different mass. In Part 2, we present further evidence on the production of mesons, which allows us to show that many of the observed mesons are locally generated in the 'explosive' disintegration of nuclei, and to discuss the relationship of the different types of mesons observed in photographic plates to the penetrating component of the cosmic radiation investigated in experiments with Wilson chambers and counters.

Part I. Existence of Mesons of Different Mass

As in the previous communications[1], we refer to any particle with a mass intermediate between that of a proton and an electron as a meson. It may be emphasized that, in using this term, we do not imply that the corresponding particle necessarily has a strong interaction with nucleons, or that it is closely associated with the forces responsible for the cohesion of nuclei.

We have now observed a total of 644 meson tracks which end in the emulsion of our plates. 451 of these were found, in plates of various types, exposed at an altitude of 2,800 m. at the Observatory of the Pic du Midi, in the Pyrenees; and 193 in similar plates exposed at 5,500 m. at Chacaltaya in the Bolivian Andes. The 451 tracks in the plates exposed at an altitude of 2,800 m. were observed in the examination of 5 c.c. emulsion. This corresponds to the arrival of about 1·5 mesons per c.c. per day, a figure which represents a lower limit, for the tracks of some mesons may be lost through fading, and through failure to observe tracks of very short range. The true number will thus be somewhat higher. In any event, the value is of the same order of magnitude as that we should expect to observe in delayed coincidence experiments at a height of 2,800 m., basing our estimates on the observations obtained in similar experiments at sea-level, and making reasonable assumptions about the increase in the number of slow mesons with altitude. It is therefore certain that the mesons we observe are a common constituent of the cosmic radiation.

Photomicrographs of two of the new examples of secondary mesons, Nos. III and IV, are shown in Figs. 1 and 2. Table 1 gives details of the characteristics of all events of this type observed up to the time of writing, in which the secondary particle comes to the end of its range in the emulsion.

Table 1

Event No.	Range in emulsion in microns of Primary meson	Secondary meson
I	133	613
II	84	565
III	1040	621
IV	133	591
V	117	638
VI	49	595
VII	460	616
VIII	900	610
IX	239	666
X	256	637
XI	81	590

Mean range $614 \pm 8\,\mu$. Straggling coefficient $\sqrt{\Sigma\Delta_i^2/n} = 4{\cdot}3$ per cent, where $\Delta_i = R_i - \bar{R}$, R_i being the range of a secondary meson, and $\bar{R}$ the mean value for n particles of this type.

The distribution in range of the secondary particles is shown in Fig. 3. The values refer to the lengths of the projections of the actual trajectories of the particles on a plane parallel to the surface of the emulsion. The true ranges cannot, however, be very different from the values given, for each track is inclined at only a small angle to the plane of the emulsion over the greater part of its length. In addition to the results for the secondary mesons which stop in the emulsion, and which are represented in Fig. 3 by black squares, the length of a number of tracks from the same process, which pass out of the emulsion when near the end of their range, are represented by open squares.

The μ-Decay of Mesons

Two important conclusions follow from these measurements. Our observations show that the directions of ejection of the secondary mesons are orientated at random. We can therefore calculate the probability that the trajectory of a secondary

* This article contains a summary of the main features of a number of lectures given, one at Manchester on June 18 and four at the Conference on Cosmic Rays and Nuclear Physics, organised by Prof. W. Heitler, at the Dublin Institute of Advanced Studies, July 5–12. A complete account of the observations, and of the conclusions which follow from them, will be published elsewhere.

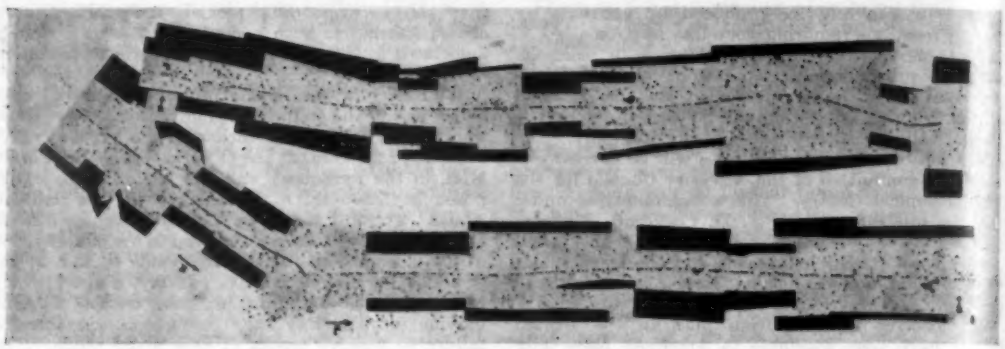

Fig. 1. Observation by Mrs. I. Powell. Cooke × 95 achromatic objective; *C*2 Ilford Nuclear Research emulsion loaded with boron. The track of the μ-meson is given in two parts, the point of junction being indicated by *a* and an arrow

meson, produced in a process of the type which we observe, will remain within the emulsion, of thickness 50 μ, for a distance greater than 500 μ. If we assume, as a first approximation, that the trajectories are rectilinear, we obtain a value for the probability of 1 in 20. The marked Coulomb scattering of mesons in the Nuclear Research emulsions will, in fact, increase the probability of 'escape'. The six events which we observe in plates exposed at 2,800 m., in which the secondary particle remains in the emulsion for a distance greater than 500 μ, therefore correspond to the occurrence in the emulsion of 120 ± 50 events of this particular type. Our observations, therefore, prove that the production of a secondary meson is a common mode of decay of a considerable fraction of those mesons which come to the end of their range in the emulsion.

Second, there is remarkable consistency between the values of the range of the secondary mesons, the variation among the individual values being similar to that to be expected from 'straggling', if the particles are always ejected with the same velocity. We can therefore conclude that the secondary mesons are all of the same mass and that they are emitted with constant kinetic energy.

If mesons of lower range are sometimes emitted in an alternative type of process, they must occur much less frequently than those which we have observed; for the geometrical conditions, and the greater average grain-density in the tracks, would provide much more favourable conditions for their detection. In fact, we have found no such mesons of shorter range. We cannot, however, be certain that mesons of greater range are not sometimes produced. Both the lower ionization in the beginning of the trajectory, and the even more unfavourable conditions of detection associated with the greater lengths of the tracks, would make such a group, or groups, difficult to observe. Because of the large fraction of the mesons which, as we have seen, can be attributed to the observed process, it is reasonable to assume that alternative modes of decay, if they exist, are much less frequent than that which we have observed. There is, therefore, good evidence for the production of a single homogeneous group of secondary mesons, constant in mass and kinetic energy. This strongly suggests a fundamental process, and not one involving an interaction of a primary meson with a particular type of nucleus in the emulsion. It is convenient to refer to this process

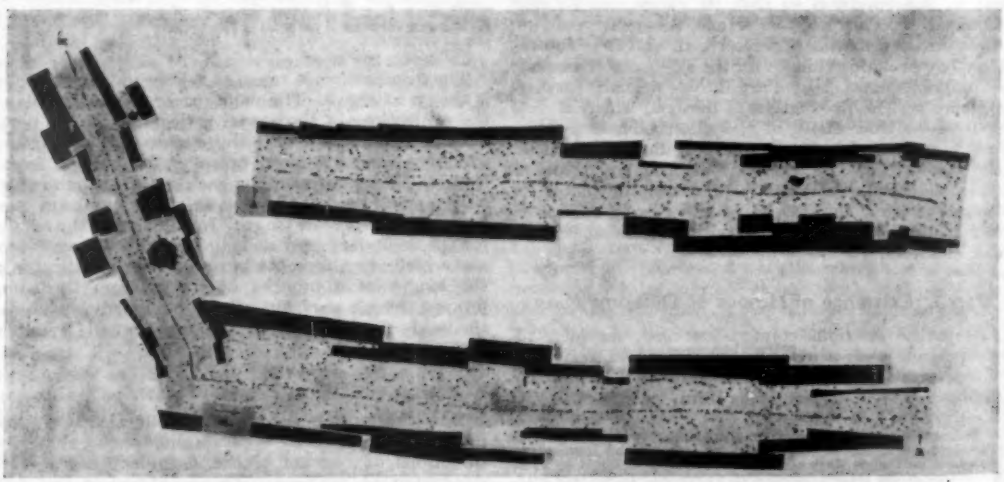

Fig. 2. Cooke × 95 achromatic objective. *C*2 Ilford Nuclear Research emulsion loaded with boron

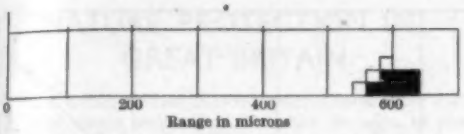

Fig. 3. DISTRIBUTION IN RANGE OF TEN SECONDARY MESONS. THOSE MARKED ■ STOP IN THE EMULSION; THE THREE MARKED □ LEAVE THE EMULSION WHEN NEAR THE END OF THEIR RANGE. MEAN RANGE OF SECONDARY MESONS, 606 MICRONS. THE RESULTS FOR EVENTS Nos. VIII TO XI ARE NOT INCLUDED IN THE FIGURE

in what follows as the μ-decay. We represent the primary mesons by the symbol π, and the secondary by μ. Up to the present, we have no evidence from which to deduce the sign of the electric charge of these particles. In every case in which they have been observed to come to the end of their range in the emulsion, the particles appear to stop without entering nuclei to produce disintegrations with the emission of heavy particles.

Knowing the range-energy relation for protons in the emulsion, the energy of ejection of the secondary mesons can be deduced from their observed range, if a value of the mass of the particles is assumed. The values thus calculated for various masses are shown in Table 2.

TABLE 2

Mass in m_e	100	150	200	250	300
Energy in MeV.	3·0	3·6	4·1	4·5	4·85

No established range-energy relation is available for protons of energies above 13 MeV., and it has therefore been necessary to rely on an extrapolation of the relation established for low energies. We estimate that the energies given in Table 2 are correct to within 10 per cent.

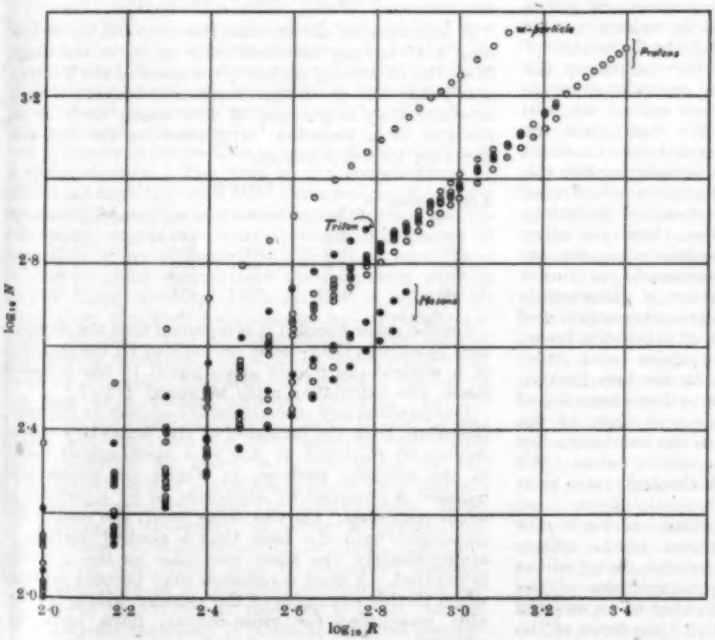

Fig. 4. N IS TOTAL NUMBER OF GRAINS IN TRACK OF RESIDUAL RANGE R (SCALE-DIVISIONS). 1 SCALE-DIVISION = 0·85 MICRONS

Evidence of a Difference in Mass of π- and μ-Mesons

It has been pointed out[1] that it is difficult to account for the μ-decay in terms of an interaction of the primary meson with the nucleus of an atom in the emulsion leading to the production of an energetic meson of the same mass as the first. It was therefore suggested that the observations indicate the existence of mesons of different mass. Since the argument in support of this view relied entirely on the principle of the conservation of energy, a search was made for processes which were capable of yielding the necessary release of energy, irrespective of their plausibility on other grounds. Dr. F. C. Frank has re-examined such possibilities in much more detail, and his conclusions are given in an article to follow. His analysis shows that it is very difficult to account for our observations, either in terms of a nuclear disintegration, or of a 'building-up' process in which, through an assumed combination of a negative meson with a hydrogen nucleus, protons are enabled to enter stable nuclei of the light elements with the release of binding energy. We have now found it possible to reinforce this general argument for the existence of mesons of different mass with evidence based on grain-counts.

We have emphasized repeatedly[1] that it is necessary to observe great caution in drawing conclusions about the mass of particles from grain-counts. The main source of error in such determinations arises from the fugitive nature of the latent image produced in the silver halide granules by the passage of fast particles. In the case of the μ-decay process, however, an important simplification occurs. It is reasonable to assume that the two meson tracks are formed in quick succession, and are subject to the same degree of fading. Secondly, the complete double track in such an event is contained in a very small volume of the emulsion, and the processing conditions are therefore identical for both tracks, apart from the variation of the degree of development with depth. These features ensure that we are provided with very favourable conditions in which to determine the ratio of the masses of the π- and μ-mesons, in some of these events.

In determining the grain density in a track, we count the number of individual grains in successive intervals of length 50 μ along the trajectory, the observation being made with optical equipment giving large magnification (× 2,000), and the highest available resolving power. Typical results for protons and mesons are shown in Fig. 4. These results were obtained from observations on the tracks in a single plate, and it will be seen that there is satisfactory resolution between the curves for particles of different types. The 'spread' in the results for

different particles of the same type can be attributed to the different degrees of fading associated with the different times of passage of the particles through the emulsion during an exposure of six weeks.

Applying these methods to the examples of the μ-decay process, in which the secondary mesons come to the end of their range in the emulsion, it is found that in every case the line representing the observations on the primary meson lies above that for the secondary particle. We can therefore conclude that there is a significant difference in the grain-density in the tracks of the primary and secondary mesons, and therefore a difference in the mass of the particles. This conclusion depends, of course, on the assumption that the π- and μ-particles carry equal charges. The grain-density at the ends of the tracks, of particles of both types, are consistent with the view that the charges are of magnitude $|e|$.

A more precise comparison of the masses of the π- and μ-mesons can only be made in those cases in which the length of the track of the primary meson in the emulsion is of the order of 600 μ. The probability of such a favourable event is rather small, and the only examples we have hitherto observed are those listed as Nos. III and VIII in Table 1. A mosaic of micrographs of a part only of the first of these events is reproduced in Fig. 1, for the length of the track of the μ-meson in the emulsion exceeds 1,000 μ. The logarithms of the numbers of grains in the tracks of the primary and secondary mesons in this event are plotted against the logarithm of the residual range in Fig. 5. By comparing the residual ranges at which the grain-densities in the two tracks have the same value, we can deduce the ratio of the masses. We thus obtain the result $m_\pi/m_\mu = 2{\cdot}0$. Similar measurements on event No. VIII give the value 1·8. In considering the significance which can be attached to this result, it must be noticed that in addition to the standard deviations in the number of grains counted, there are other possible sources of error. Difficulties arise, for example, from the fact that the emulsions do not consist of a completely uniform distribution of silver halide grains. 'Islands' exist, in which the concentration of grains is significantly higher, or significantly lower, than the average values, the variations being much greater than those associated with random fluctuations. The measurements on the other examples of μ-decay are much less reliable on account of the restricted range of the π-mesons in the emulsion; but they give results lower than the above values. We think it unlikely, however, that the true ratio is as low as 1·5.

The above result has an important bearing on the interpretation of the μ-decay process. Let us assume that it corresponds to the spontaneous decay of the heavier π-meson, in which the momentum of the μ-meson is equal and opposite to that of an emitted photon. For any assumed value of the mass of the μ-meson, we can calculate the energy of ejection of the particle from its observed range, and thus determine its momentum. The momentum, and hence the energy of the emitted photon, is thus defined; the mass of the π-meson follows from the relation

$$c^2 m_\pi = c^2 m_\mu + E_\mu + h\nu.$$

It can thus be shown that the ratio m_π/m_μ is less than 1·45 for any assumed value of m_μ in the range from 100 to 300 m_e, m_e being the mass of the electron (see Table 3). A similar result is obtained if it is assumed that a particle of low mass, such as an electron or a neutrino, is ejected in the opposite direction to the μ-meson.

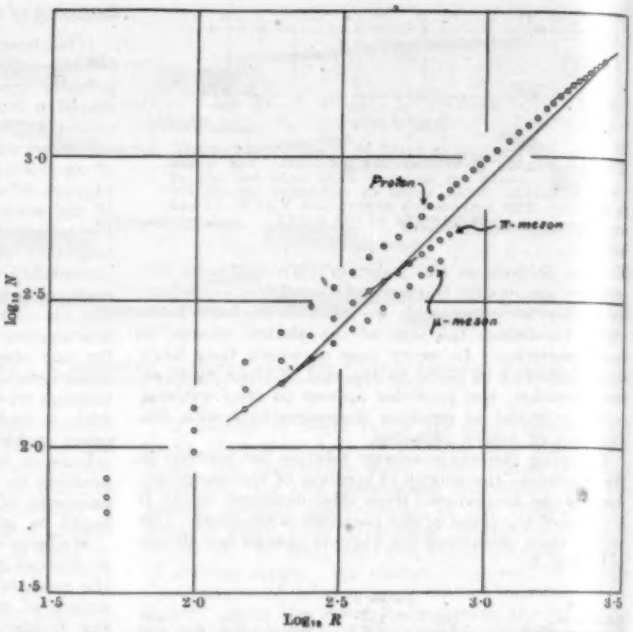

Fig. 5. N IS TOTAL NUMBER OF GRAINS IN TRACK OF RESIDUAL RANGE R (SCALE-DIVISIONS). 1 SCALE-DIVISION = 0·85 MICRONS
THE 45°-LINE CUTS THE CURVES OF THE MESONS AND PROTON IN THE REGION OF THE SAME GRAIN DENSITY

TABLE 3

Assumed mass m_μ	R (MeV.)	Δv (MeV.)	m_π	$m_\pi/m_\mu \pm 3$ per cent
100 m	3·0	17	140 m_e	1·40
150	3·6	23	203	1·35
200	4·1	29	264	1·32
250	4·5	34	325	1·30
300	4·85	39	387	1·29

On the other hand, if it is assumed that the momentum balance in the μ-decay is obtained by the emission of a neutral particle of mass equal to the μ-meson mass, the calculated ratio is about 2·1 : 1.

Our preliminary measurements appear to indicate, therefore, that the emission of the secondary meson cannot be regarded as due to a spontaneous decay of the primary particle, in which the momentum balance is provided by a photon, or by a particle of small rest-mass. On the other hand, the results are consistent with the view that a neutral particle of approximately the same rest-mass as the μ-meson is emitted. A final conclusion may become possible when further examples of the μ-decay, giving favourable conditions for grain-counts, have been discovered.

[1] *Nature*, **159**, 93, 186, 694 (1947).

NATURE PROTECTION IN GREAT BRITAIN

THE concept that Nature cannot look after itself and needs protection from the ravages of man in the interests of man is comparatively modern. The problem arose only when the increasing use of coal, the invention of steam power, and the consequent entry into the industrial age led to a large expansion of the population and its concentration into particular areas, as happened in Great Britain. The reservation of small tracts to prevent the extermination of rare plants is no novelty; in Switzerland certain plants, one being the edelweiss, have been protected in this way for a long time. The idea, however, that a whole region should be kept inviolate for all time from exploitation and development, for the benefit of the people, is comparatively recent.

The creation of what are called 'national parks' first happened in the United States of America. Some three-quarters of a century ago, a party of white explorers penetrating into what is now the Yellowstone National Park were so impressed with the stupendous grandeur of the scene that spontaneously and unanimously they decided that it ought to become the property of the nation. This expression of opinion was accepted by the Government, and by the Yellowstone Park Act of Congress of 1872 the first national park was established "as a pleasuring ground for the benefit and enjoyment of the people", to quote the Act. Thus was set in motion a movement which spread over not only the United States but also much of the civilized world. The largest of the national parks is the Kruger National Park in South Africa, and a notable one is the Albert National Park in the Belgian Congo.

The term used for these wild spaces has been criticized, because the work 'park' connotes an artificially laid out and maintained piece of land or a site for assembling vehicles, for example, artillery or automobiles. It is, however, useless at this late date to think of changing it, especially as an alternative, short of coining a new word, would be difficult, if not impossible, to suggest. There are two distinct and mutually incompatible concepts of the purpose of a national park. The first is the conservation of the scene and the wild life contained in it, which necessarily entails the restriction of human access. Obviously, vegetation cannot remain unimpaired if humanity in its thousands is allowed to roam over it, and to pluck flowers and uproot plants at will. In the Swiss National Park no one is allowed to stray from the high road except by permission or under guidance, and no interference with natural processes is tolerated; even fallen trees are allowed to decay in peace. The second concept is the use of the area as a public pleasure ground. In the enormous stretches of national parks in the United States and elsewhere the two concepts may easily be harmonized, for there is ample space for the accommodation and amusement of tourists without sensible encroachment upon the natural scene. Even so, warding is necessary, in order to ensure that tourists obey regulations and do no harm, especially by starting fires which may do extensive damage. The importance of a biological service to take advantage of the national park as a great natural laboratory for the study of plant and animal associations and of the relation to the character of the soil needs no stressing.

The creation of national parks in a small and densely populated country like Great Britain, and particularly England and Wales, is a very different problem. Here are no large virgin regions which may be declared public property without disturbance of private ownership or local administration, and national parks, from which the public would be largely excluded in the interest of the wild life there, are not feasible. On the other hand, Great Britain, though so small in extent, is favoured with beautiful landscape of a remarkably varied character, ranging from the grandeur of the Scottish Highlands and the Welsh mountains, the open expanse of the Yorkshire moors, and the contrasting combination of fell and water in the Lake District, to the rolling downs and smiling fields of the south. Such landscape is a great national asset and should be treated as such, and the establishment of national parks in this sense is highly desirable. The initiation of the movement to this end is due to the Council for the Preservation of Rural England, which in 1929 submitted a memorandum on the subject to the then Prime Minister. In consequence a Government committee under the chairmanship of Dr. Christopher (now Viscount) Addison was appointed to consider the desirability and feasibility of establishing national parks in Great Britain. The report[1], which favoured such establishment, appeared two years later; but unhappily the economic crisis supervened and nothing was done to implement its recommendations. The matter might, indeed, have passed into oblivion but for the action of the Council, which, in conjunction with the similar body for Wales, set up in 1935 the Standing Committee on National Parks, composed of representatives of the organisations that presented evidence to the Addison Committee. By means of questions in Parliament and in other ways the subject was kept alive. A debate was being planned in the House of Lords in the summer of 1939, when the imminence of war brought progress to a standstill.

The setback proved to be only temporary; planning was in the air, and the possible provision of national parks and Nature reserves could not be ignored in schemes for the use of the land. In the report[2] of the committee under the chairmanship of Lord Justice Scott the establishment of national parks and Nature reserves was recommended and, for the first time in an official document, the preservation of geological monuments was advocated. Under the auspices of the Society for the Promotion of Nature Reserves, a Conference on Nature Preservation in Post-War Reconstruction, composed of delegates representing national societies interested in the subject and organisations of local authorities, was convened in 1941, and reported[3] that, as regards national parks: (*a*) steps should be taken to implement generally the recommendations of the National Park Committee made in its report, and in particular to set up national park authorities, which would be responsible for matters of general policy, one for England and Wales and one for Scotland, with a joint committee to co-ordinate the working of the two; (*b*) the management and administration of areas comprised in national parks and Nature reserves should, so far as desirable, be undertaken locally, in which matter local authorities should play the leading part with the help of persons with special knowledge or interest; and (*c*) the facilities given to the public and students on Government properties should be considered and made part of a unified policy for the needs here discussed. As regards

Nature reserves, (*a*) the principle of establishing Nature reserves and sanctuaries should be accepted as part of the general national planning schemes; (*b*) an official body, representative of the scientific interests concerned, should be appointed to draw up detailed proposals; and (*c*) the management of reserves and sanctuaries should be placed only in the hands of persons fully conversant with the highly technical problems included in the maintenance of the balance of life, and the general control should be vested in a central authority, representative of the different interests concerned. At the same time, the Conference recommended the official recognition of what were afterwards known as conservation areas, which should be preserved in their present unspoilt state. The Conference's short but valuable document has scarcely received the attention its importance deserves.

But the Conference did not stop there, and in 1942, in response to official request, appointed the Nature Reserves Investigation Committee. Without assistance from public funds and with the aid of only a small grant from the Pilgrim Trust, this Committee, despite the perils of those tragic years, carried out a comprehensive natural history survey of England and Wales. Though taken for granted at home, this work at such a time aroused wondering amazement abroad. It first issued a memorandum[4] on general principles, and then created an elaborate machine made up of twenty-four regional committees and a geological sub-committee. As the result of their investigations two memoranda were published: the first[5] on geological features and the second on wild life[6]. The separate regional reports were not published, but they were duplicated and thus made available to planning authorities and officers. Almost simultaneously a Committee of the British Ecological Society produced two reports[7].

A further stage was reached when Mr. John Dower, formerly drafting secretary of the Standing Committee on National Parks, was enlisted by the newly formed Ministry of Town and Country Planning to study the problem of national parks so far as it affected England and Wales. He submitted an elaborate and detailed report[8]. Its public welcome impelled the Ministry to delve still deeper into the complex questions involved, and to appoint a committee under the chairmanship of Sir Arthur Hobhouse for the purpose of considering the Dower Report, and making recommendations for the selection, delimitation, and administration of national parks, and for ancillary matters, including the conservation of wild life and the provision of footpaths and access to the countryside. The conservation of wild life was referred to a special committee, of which Dr. Julian Huxley was chairman and Prof. A. G. Tansley vice-chairman, and the other matter to another special committee under the chairmanship of Sir Arthur himself.

In the principal report[9] the desirability of national parks is accepted; but it is realized that their function will be more the spiritual and bodily refreshment of the people, especially the inhabitants of cities and towns, than the protection of wild life. The Committee recommends that their control should be entrusted to a National Park Commission, which would be responsible to the Minister of Town and Country Planning. Twelve areas are selected as national parks, to be created in three annual instalments. Of these, nine are in category *A* of the Dower Report, two are in category *B* and one is in category *C*; the last, the South Downs, is raised in status because of its proximity to London. Their management is to be handed to park committees, of which the chairman and one half of the other members would be appointed by the Commission and the other half by the local authorities concerned, an arrangement that may be expected to prove satisfactory provided that the two halves work in harmony and not in opposition. The main function of the Commission would be to control the development and use of the land of the national parks; conflict with Government departments is to be resolved by a permanent committee of the Cabinet created for the purpose. The setting up of a Coastal Planning Advisory Committee is recommended, and the need for national planning to resist coastal erosion is realized. The total capital cost is estimated to be £9,250,000, some of which, at least, would be suitable for grants from the Land Fund. In addition to the main areas the Minister is recommended to declare other similar, but smaller, tracts 'conservation areas', a term introduced by the Nature Reserves Investigation Committee, to be controlled by advisory committees. The total annual cost of all areas in Britain is estimated to be £170,000, rising eventually to £750,000.

The scope of the second report[10] covers more than the areas selected as national parks, since tracts of scientific interest whether for their wild life or for their geological features are not necessarily restricted to them. Frank and full acknowledgment is made of the value of the work of the Nature Reserves Investigation Committee, and the recommendations of the latter body for national Nature reserves and conservation areas and for geological features are adopted with but slight modifications. Reference is made also to the reports of the British Ecological Society mentioned above. Stress is laid upon the necessity for the proper maintenance of these natural features and the investigation of their scientific characters, and the establishment of a biological service for the purpose under the control, initially at least, of the Lord President of the Council, is recommended; specialists when needed would be seconded from the Geological Survey or the British Museum (Natural History). From the reference to the Society for the Promotion of Nature Reserves, it might be supposed that it depended for its income mainly on the endowment by the Hon. Charles Rothschild. Unhappily, at the present time that part of its income barely suffices to meet half the cost of maintaining the Nature reserve given by him and added to by his wife. The Society defrays its other activities almost entirely from the income from the far larger bequest made by Dr. G. Claridge Druce.

During recent years, distinct but complementary work has been carried on in Scotland. At the instance of the Association for the Preservation of Rural Scotland, the Scottish Council for National Parks was set up in 1943. The Scottish National Parks Survey Committee, with Sir J. Douglas Ramsay as chairman, was appointed in 1944, and in its report[11], which was issued soon after the Dower Report, various areas are recommended as national parks and various tracts as Nature reserves. The Scottish National Parks Committee under the same chairmanship was formed early in 1946 to study the detailed arrangements entailed by the previous proposals, and the Scottish Wild Life Conservation Committee, with Prof. James Ritchie as chairman, was appointed to advise it on the natural history aspect.

It is not unduly rash to say that a long way has been traversed towards the realization of the vision that inspired a few enlightened men and women eighteen years ago. Then it faded and all but vanished under the chill blast of the economic blizzard. Now that the vision once more seems on the point of taking shape, it has to face yet another such crisis. If a similar fate is not to befall it, the Government must be urged to appoint forthwith the National Parks Commission and at least the nucleus of the biological service.

G. F. HERBERT SMITH

[1] The Report of the National Parks Committee. Cmd. 2851. (London: H.M. Stationery Office, 1931.)

[2] Report of the Committee on Land Utilisation in Rural Areas. Cmd. 6378. (London: H.M. Stationery Office, 1942.)

[3] Memorandum No. 1. (London: Society for the Promotion of Nature Reserves, 1941; second edition, 1942.)

[4] Nature Conservation in Great Britain, No. 3. (London: Society for the Promotion of Nature Reserves, 1943; second edition, 1945.)

[5] National Geological Reserves in England and Wales, No. 5. (London: Society for the Promotion of Nature Reserves, 1945; second edition 1946.)

[6] National Nature Reserves and Conservation Areas in England and Wales. No. 6. (London: Society for the Promotion of Nature Reserves, 1945.)

[7] Memorandum on Wild Life Conservation and Ecological Research from the National Standpoint; Nature Conservation and Nature Reserves. (London: Cambridge University Press, 1943.)

[8] National Parks in England and Wales. Cmd. 6628. (London: H.M. Stationery Office, 1945.)

[9] Ministry of Town and Country Planning. Report of the National Parks Committee (England and Wales). Cmd. 7121. Pp. ii+144. (London: H.M. Stationery Office, 1947.) 4s. 6d. net.

[10] Ministry of Town and Country Planning. Conservation of Nature in England and Wales. Report of the Wild-Life Conservation Special Committee (England and Wales). Pp. v+139. Cmd. 7122. (London: H.M. Stationery Office, 1947.) 4s. net.

[11] National Parks: a Scottish Survey. Cmd. 6631. (London: H.M. Stationery Office, 1945.)

OBITUARIES

Prof. E. Laqueur

THE death of Prof. Ernst Laqueur at the age of sixty-eight occurred on August 19, while he was on holiday in Switzerland.

Laqueur's death removes from the field one of the pioneers of modern endocrinology, and particularly that branch of it dealing with the sex hormones. Laqueur had had a very sound training in both chemistry and biological methods, and was himself also a qualified physician. This latter training gave him that great interest in the practical application of scientific work which undoubtedly acted as a stimulus for his investigations into the internal secretions.

His first major contribution to the subject of endocrinology occurred in the very early days of insulin. In the close of the year 1922, Banting and Best had published their classical paper demonstrating the presence of a stable anti-diabetic substance in the pancreas. From that moment biochemists all over the world concentrated on attempts to make possible the production, on an economic basis, of this new substance, insulin. Well in the forefront of this investigation was Prof. Laqueur with his team at Amsterdam. They made a large number of very important communications on both the preparation and the properties of insulin.

It was, however, mainly on the question of the sex hormones that Prof. Laqueur's reputation rests. It will be remembered that in 1924 Allen and Doisy started an entirely new epoch in research on the female sex hormone by applying the vaginal smear method of Stockard and Papanicolaou to the standardization of the ovarian hormone, as it was then called. Prof. Laqueur immediately started work on similar lines and was certainly in possession of one of the purest specimens of the hormone up to the time of the announcement by Aschheim and Zondek of the presence of the hormone in the urine of pregnancy. Again, this discovery completely changed the whole outlook on the biochemical research into the nature of the hormone; but again Prof. Laqueur was well in the forefront in the crystallization of the hormone from the new source.

In the early 1930's, Butenandt had succeeded in isolating a steroid substance from male urine. This substance, androsterone, proved to have the properties of the male sex hormone in that it was capable of causing growth of the capon's comb. Laqueur was the first to point out that an extract of the testis could be obtained which was more powerful, weight for weight, than the actual crystalline androsterone. At first Laqueur inclined to the view that there was some activator present in the testes and suggested the name of the '*X* substance'. Later, however, he characterized the actual hormone and named it 'testosterone'. This research was brought into line with the brilliant discoveries being made at Zurich in the laboratories of Prof. Ruzicka. He had shown that by oxidizing away the side-chain of sterols such as cholesterol, it was possible to obtain the cyclopenteno-phenanthrene nucleus with the right stereochemical configuration, and that this could be used as a basis for the partial synthesis of sex hormones. Testosterone is produced by this method. We have, therefore, in this brilliant research of Prof. Laqueur an excellent example in which skilful and penetrating biological observational work can be combined with organic chemistry, leading to the isolation, characterization and large-scale production of new compounds.

Prof. Laqueur was a frequent visitor to Britain and was well known to all those who worked in this field through his assistance at the various international congresses before the War. With the invasion of Holland by the Germans he was removed from his post, and both he and his family were subjected to the cruellest of treatment. He emerged from the War with severely impaired health, but those who saw him after his ordeal commented on his completely unbroken spirit.

Holland and the science of endocrinology have lost a great pioneer.

E. C. DODDS

Prof. Ll. Rodwell Jones

BY the death on August 15 of Ll. Rodwell Jones, shortly before his sixty-sixth birthday, British geography has lost one of its rapidly dwindling group of 'elder statesmen'.

Rodwell Jones was born on August 28, 1881. In due course he proceeded from Kingswood School, Bath, to the University of London, where he took a science degree, and then commenced school-teaching. It was while so engaged that he came under the stimulating influence of Mackinder, then at the London School of Economics, and found his vocation in geography. An appointment as lecturer in geography in the University of Leeds in 1913 was all too soon interrupted by the First World War, in which he served in the West Yorkshire Regiment, reached the rank of major and was decorated with the Military Cross. Shortly after his release from the

army he returned to London to join Mackinder's staff at the London School of Economics, and in 1925 succeeded him as professor of geography and co-head of the King's College, London School of Economics Joint School of Geography. He had planned to retire on reaching the age of sixty, but the Second World War necessitated an unwelcome postponement, and it was not until 1945 that he felt justified in vacating his post.

It is difficult to assess with any confidence the relative value of Rodwell Jones's contributions to his subject. His output of published work was limited both by his devotion to the needs and interests of his very large department and by his extremely exacting standards of scholarship. He committed nothing to print until he had tested and re-tested materials and methods, and satisfied himself of the soundness of his conclusions. His major works, "Northern England", "North America" (in collaboration with Dr. P. W. Bryan), and "The Geography of London River" are, in consequence, not merely interpretations of first-class importance, but models of method as well. Yet it is as class teacher and research adviser that he will probably be most vividly and gratefully remembered by his students. Shy in nature, and lacking the platform brilliance of a Mackinder or a Lyde, he gained the respect, admiration and enduring affection of successive generations of students, who experienced at close range the humour and the kindliness behind his shyness, and were helped to acquire permanent habits of critical and constructive thinking in their subject.

NEWS and VIEWS

International Control of Atomic Energy

Sir Charles Darwin opened a discussion on "Atomic Energy and the Veto" which formed part of the programme of a meeting of the Atomic Scientists' Association held at Oxford on September 20. He said he wanted to examine carefully the grounds on which a case might be built for treating atomic energy in a different way from other armaments, in the setting up of the proposed Atomic Development Administration and in its freedom from the veto. This he analysed coldly under seven headings: (1) pure military, (2) novelty, (3) mass destruction, (4) start of war, (5) treachery, (6) scale effect and (7) feasibility. Under the first three headings he found no reason for special treatment; but under the last three he found there is a definite case. The strongest argument is the unanimous report of the Atomic Energy Technical Committee of the United Nations Organisation that international control is, in fact, a workable proposition from a technical point of view. Sir Charles discussed the seven headings in some detail. In relation to (1), he said he thought that the atomic bomb is not a 'good weapon'. Although it would certainly be effective for use on naval bases, he did not believe it would be used for land warfare. In relation to (4), he said that although the bomb could deliver a tremendous blow, it could not prevent retaliation in kind, which he thought might act as a severe deterrent to its use. With regard to (5), he stressed the possible use of the bomb as a secret weapon of treachery by an unidentifiable third party in a dispute.

Prof. N. F. Mott, in thanking Sir Charles Darwin, said he thought there might be a case for 'de-bunking' the atomic bomb, but wondered whether Sir Charles had not 'de-bunked' it too much. Dr. W. J. Arrol stressed the importance from a purely military point of view of attacks on ports and convoys. The extreme danger of its use for attack on industry and for mass-destruction was implicit in the remarks of most of the speakers. Captain Blackburn, M.P., for example, said that the scientific men had done their job in showing that atomic control is technically feasible, and that the problem is now a political one. Control is being frustrated, he said, by the U.S.S.R., and he advocated an urgent meeting of Mr. Attlee and Mr. Truman with Mr. Stalin to put the danger to the latter in the plainest terms. Failing agreement, peace-loving nations must develop predominance in atomic and other power. Mr. Conybeare did not agree that the U.S.S.R. is frustrating control, and Dr. H. W. B. Skinner said that, while agreeing with most of Captain Blackburn's remarks, he deprecated the atmosphere of crisis. Dr. A. T. Waterman, a guest from the United States, stressed the value of international co-operation in science. Dr. K. Lonsdale asked whether there would be any purpose in the Association of Atomic Scientists calling on scientific workers not to take part in the manufacture of atomic weapons; but Prof. Mott thought that it would not be possible to secure a majority opinion on this suggestion. Another speaker complained of the placidity of the discussion of a situation in which we were running into another war, and there was some argument as to the future aim of the Association, Mr. Freedman, in particular, feeling a lack of guidance in the present dangerous situation. But Prof. R. E. Peierls said that, though scientific men should not be afraid of politics, policy must be clear-cut and united. Urgency does not replace judgment, and he felt that, at present, no straightforward lead could be given. The functions of the Association must therefore remain for the moment mainly educational.

Electron Jubilee Exhibition

To mark the fiftieth anniversary of the discovery of the electron, an exhibition, illustrating the scientific and industrial developments and the numerous electronic devices resulting from that discovery, is being held at the Science Museum, London. The exhibition is arranged around one gallery of the Museum, and is divided into eight sections, each of which is devoted to one particular aspect of the subject. By photographs, diagrams (some of which are animated), working exhibits, and the display of historical and modern apparatus, the visitor is shown how the wave-like and particle-like properties of the electron were discovered, and is given an appreciation of the way in which these discoveries have opened up a new era, both in science and industry.

An attractive handbook to the Exhibition, with an intriguing cover and a photograph of Sir J. J. Thomson, the discoverer of the electron, as frontispiece, has been prepared by Mr. D. H. Follett (Institute of Physics, London. 1*s.* 2*d.* post paid). It is in two parts. The first is a guide to the exhibition and lists the exhibits in the eight sections in the order in which they are displayed. The second is a descriptive account of the background to the several

exhibits. It is well written, and the reader with some knowledge of physics will find that it gives an accurate summary of the history of the electron during the past fifty years. The subjects dealt with include: the discovery of the electron and the measurement of its charge; the thermionic valve and the cathode ray tube; the photo-electric effect and devices; atomic structure; electron diffraction; X-rays; and the conduction of electrons in gases and solids. It is a pity that no illustrations of the actual exhibits are given. Doubtless a third part to the handbook, similar to that produced for the 'low-temperature' exhibition several years ago, with photographs of the exhibits and exhibition, would receive a welcome. The exhibition will remain open to the public for three months.

Automatic Control on Atlantic Flight

A U.S. Air Force "Skymaster" transport aircraft flew from Stephenville, Newfoundland, to Brize Norton R.A.F. Station in Oxfordshire, on September 22, a distance of 2,400 miles across the Atlantic, including taking off and landing, without being controlled in any way by the crew on board. The machine was commanded by Colonel J. N. Gillespie of the U.S. Air Force, and carried a number of scientific observers as well as the normal crew. The apparatus automatically controls the take-off and climb to an arranged height. It then homes on a beam sent out by a radio beacon. In this case these came from two successive ships on the way across, and then from Brize Norton. Finally, it sets the machine into the required glide, lands and brakes. In the United States the system is understandably described as 'push button flying'.

The real significance of this system lies in the ability to make landings at the end of the flight. Automatic control of direction during a flight has been in use successfully for some time. A flight can now be commenced without fear as to what the weather conditions will be at the end of it. The radio control is independent of the weather and can land a machine under conditions in which human control would be impossible; in bad visibility, for example. The apparatus is such that it can be fitted to any aircraft of sufficient capacity; in fact, the machine which has just crossed the Atlantic was a standard Skymaster of the U.S. Air Force. The system would not be applicable to bombing raids, as it depends upon radio co-operation from the terminal point, which would not be available from the enemy territory.

Correspondence of Isaac Newton

ALTHOUGH Isaac Newton is acclaimed as the greatest leader of scientific thought that the world has known, there exists no satisfactory collected edition of his works. The Council of the Royal Society has decided to make a first step in the arduous undertaking of preparing such an edition by producing in a worthy form the collected correspondence of Newton, which will comprise letters written by him and the replies to them. Prof. H. W. Turnbull has undertaken the editorship of this work. The Council of the Royal Society has entrusted the immediate organisation of the publication of the Newton correspondence to a sub-committee of the Society, under the chairmanship of Prof. E. N. da C. Andrade. It is hoped that learned institutions, museums, libraries and collections will collaborate in the work, by notifying the assistant secretary of the Royal Society of any letters of Newtonian interest that they may possess, and by lending the letters to the Society for a brief period or by arranging with the Society for photographic copies to be made.

Overseas Broadcast of the British Association Meeting

A SERIOUS attempt was made by the B.B.C. to give listeners an account of the recent meeting of the British Association in Dundee, by bringing representative speakers to the microphone every day. A descriptive broadcast on Dundee and St. Andrews was also given in the B.B.C. overseas service to Germany on September 19, and repeated on September 23. The broadcast, recorded in German, included an account of the Dundee shipyards and of visits to marmalade and jute factories. There were also interviews at Dundee with Prof. J. D. Cockcroft on atomic energy, Sir Robert Watson-Watt on radar and Dr. E. B. Chain on penicillin. The account of the University of St. Andrews and of the ancient buildings of the city included interviews with Dr. C. T. Carr, lecturer in German, and Dr. John Read, professor of chemistry, whose reference to alchemical music was illustrated by a gramophone reproduction of one of Count Michael Maier's canons from "Atalanta Fugiens" (1618).

Heredity

RECENTLY there has appeared the first number of the new journal, *Heredity*, devoted, as its name indicates, to genetics (*Nature*, **159**, 599; 1947). In the past fifty years, this science has seen an expanding flow of publications—a flow which the War did little to check. Before 1939 this increase was matched by the increasing number of journals which offered facilities for the publication of findings in genetics; but far from the increase in means of publication continuing, the War has led to a reduction in the number of genetics journals in Europe. The appearance of a new one is therefore particularly welcome at the present time. *Heredity* is jointly edited by Dr. C. D. Darlington and Prof. R. A. Fisher, and it is published by Messrs. Oliver and Boyd of London and Edinburgh. Its international nature is emphasized by the board of five collaborating editors, of whom three are from Europe and two from the United States. The editorial policy is a liberal one both in the types of articles which will be accepted and in the fields from which they will be drawn. Historical, review and critical contributions will find their places beside the records of new research; and cytology, statistics, biochemistry, evolutionary theory and breeding work will all be accepted in so far as they are related to genetics. The new journal is to appear three times a year.

The first number of *Heredity* well illustrates how this editorial policy is put into practice. It contains ten articles, covering a wide field in their nature, in their subject-matter and in the countries from which they originate. The first two form a novel departure and one which should do much towards overcoming the consequences of difficulty in communication during the war years. These are, respectively, a summary of genetical research in Great Britain during 1939–45, and a bibliography of German and Italian research during the same period. Though running to some six hundred titles, this list is not complete in its German section, and a supplementary bibliography is promised. Two short papers describe a new gene

and a new linkage in the mouse, and a third is devoted to the colour inheritance and sex-determination in the fish, *Lebistes*. From the plant side come two papers: one on the interaction of self-incompatibility genes when, contrary to their usual situation, two are present in the same pollen grain; and one on the theory of breeding plants for increased yield. Two further papers consider the effects of natural selection, in one as exemplified by change with time in frequency of certain chromosome types in *Drosophila*, and in the other by the change with climate in frequency of a gene causing a waxy bloom in *Ricinus*. Finally, there is a statistical discussion of the measurement and analysis of virulence in bacteria and viruses, as it might be applied to genetical work.

International Union of Biological Sciences

THIS Union held its first post-war meeting at Copenhagen at the end of July. It was attended by delegates from the various sections and from seventeen countries. Dr. Joseph Needham attended the meeting on behalf of the United Nations Educational, Scientific and Cultural Organisation, and Prof. Borel and M. Establier on behalf of the International Council of Scientific Unions. It was agreed to form new sections of experimental cytology, embryology, genetics, microbiology and zoology. In addition to the Joint Commission on Oceanography on which the Union is represented, it was agreed to form certain new committees on border-line subjects and to invite other unions to nominate members: the subjects agreed upon were radiobiology and natural calamities. A long list of congresses and symposia were notified for the year 1948. Proposals were discussed for the publication of a catalogue of type-specimens of animal species and of historic collections, for the distribution of artificial radioactive isotopes for biological experiments and for the creation of a centre for marine biology in the Malay Archipelago. A resolution was adopted urging that all possible means be taken to prevent biological warfare. It was agreed to hold the next meeting in 1950, probably in Stockholm. The following officers were elected: *President*, Dr. M. J. Sirks (Netherlands); *Vice-President*, Prof. H. Munro Fox (Great Britain); *General Secretary*, Prof. P. Vayssière (France); *Secretary*, Prof. Stuart Mudd (United States); and *Treasurer*, Prof. Chodat (Switzerland).

Chemistry and Uses of Fluorine

A WHOLE number of *Industrial and Engineering Chemistry* (**39**, 236–435; March 1947) is devoted to the chemistry of fluorine and its compounds. The production of fluorine on the industrial scale and its storage and utilization are fully described. The common electrolytes are fused acid potassium fluorides with carbon anodes, and up to 2,000 amperes were used in the electrolysing currents. An anode current efficiency of about 95 per cent was attained. Small laboratory units are also dealt with. The gas can be piped in steel or copper, and compressed up to 400 lb./in.^{2} in nickel and steel cylinders. Purification reached 98 per cent minimum. Fluorination of hydrocarbons formed numerous products up to $C_{12}F_{26}$, and in this work much use was made of cobalt trifluoride, CoF_3, and silver difluoride, AgF_2, and reactions in liquid hydrogen fluoride. A novelty is the fluorine-hydrogen blowpipe, used for welding metals. The papers represent a notable advance in fluorine chemistry.

Archæological Work in China

OCCASIONAL PAPERS (vol. 1, No. 1) of the Freer Gallery of Art (Smithsonian Institution) is devoted to a description of the tomb of the Grand Empress Dowager Wên Ming and the Northern Wei necropolis at Fang Shan. The author (A. G. Wenley) has produced an interesting little work of some 28 pages with six full-page photographs of the site. It starts with a short account of the Empress Dowager herself, followed by a description of the necropolis and tomb where she is buried. The work itself is dedicated to the late Carl Whiting Bishop, who was associated with the Freer Gallery for twenty years and who was much interested in certain Northern Wei dynasty imperial mausolea.

German Food Industry in War-time

AN exhibition of photographs, drawings and specimens obtained in Germany by British Intelligence Objectives Sub-Committee investigating teams sponsored by the Ministry of Food will be on view in the Conference Hall, Portman Court, Portman Square, W.1, during October 15–29 each day from 10 a.m. to 4 p.m. Informal talks will be given in the exhibition at 3 p.m. on German soapless detergents (Mr. G. R. Perdue, British Launderers' Research Association); developments in the German dairying industry (Mr. F. C. White, Ministry of Food); war-time production of food yeast in Germany (Mr. H. J. Bunker, Barclay Perkins and Co., Ltd.); food preservation and refrigeration in Germany (Dr. E. C. Bate-Smith, Department of Scientific and Industrial Research).

University of London: Appointments

THE following appointments in the University of London have been announced: Mr. M. McGregor Cooper, senior lecturer in dairy husbandry at Massey Agricultural College, New Zealand, to the University chair of agriculture tenable at Wye College; Prof. W. J. Hamilton, since 1945 regius professor of anatomy in the University of Glasgow, to the University chair of anatomy tenable at Charing Cross Hospital Medical School; Prof. W. G. Holford, since 1931 Lever professor of civic design in the University of Liverpool, to the University chair of town planning tenable at University College; Dr. W. A. Lewis, lecturer in commerce at the London School of Economics and also principal in the Board of Trade and in the Colonial Office, to the University readership in Colonial economics tenable at the School.

The title of reader in mining geology in the University has been conferred on Dr. David Williams, in respect of the post held by him at the Imperial College of Science and Technology.

Announcements

THE sixth Hinchley Memorial Lecture of the Institution of Chemical Engineers will be delivered by Dr. R. V. Southwell, rector of the Imperial College of Science and Technology, on October 14 at 5.30 p.m. at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1. Dr. Southwell will speak on "Relaxation Methods: a Method for the Engineer".

DR. E. ASHWORTH UNDERWOOD, director of the Wellcome Historical Medical Museum and honorary lecturer in the University of London (University College), has been awarded the Cross of the Chevalier of the Legion of Honour.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Mode of Action of 'Paludrine'

INVESTIGATING the activity of 'Paludrine' against plasmodia in tissue culture, Tonkin[1] and Hawking[2] concluded that the drug was inactive *in vitro*, but was metabolized to an active form in the serum of the host. In view of these observations, it surprised us to find that 'Paludrine' inhibited the oxidation of glucose, pyruvate and lactate by washed chick red cells parasitized with *P. gallinaceum* more powerfully than did quinine (Table 1).

TABLE 1

Inhibitor	Conc.	% inhibition of oxygen uptake after 2 hours		
		Glucose	Pyruvate	Lactate
'Paludrine' HCl	1/300,000	4·6	Nil	Nil
	1/60,000	20·7	2·5	24·1
	1/6,000	84·5	84·0	89·4
Quinine HCl	1/60,000	10·4	5·6	5·5
	1/6,000	15·8	15·6	5·5

Determinations of glucose utilization and changes in phosphorylated intermediates in parasitized red cell incubates in the presence of 'Paludrine' and of iodoacetic acid showed that 'Paludrine' inhibition was essentially different from that of the iodoacetate (Table 2). While the latter inhibited both oxygen consumption and glycolysis, with accumulation of hexose phosphates, 'Paludrine' showed less than 50 per cent inhibition of glucose utilization, although oxygen consumption was inhibited to a greater extent. Similar observations on quinine indicated that it inhibited glycolysis rather more strongly than oxidations, probably by inhibiting the hexokinase reaction[3].

TABLE 2

	Inhibitor	Conc.	μ Mols used up (−) or formed (+) per hour per 100 μ mols glucose used by controls							
			Glucose	A.T.P.	Glucose-6-phos.	Fructose-6-phos.	Phospho-glyceric acid	Pyruvic acid	Lactic acid	Oxygen
Expt. 1	Control	—	−100	−141	−23·8		+91·3	+17·5	+625	−266
	'Paludrine' HCl	1/6,000	−69	−74	−31·3		+26·2	+13·8	+313	−31
	Iodoacetic acid	1/6,000	−11	−55	−7·4		+51·0	+2·9	+31	−58
Expt. 2	Control	—	−100	−66	−3·5	+0·7	−3·4	+3·0	−118	−71
	'Paludrine' HCl	1/3,000	−54	−26	−2·6	+1·0	+0·5	+4·3	−187	−5
	Iodoacetic acid	1/3,000	−13	−97	+8·9	+2·6	−3·1	+0·7	−414	−12

These observations suggest that 'Paludrine' exerts its anti-malarial action, at least partially, by inhibiting the oxidation processes in the parasites, but does not directly effect the anaerobic breakdown of glucose to lactic acid. However, higher concentrations of 'Paludrine' than those used by Tonkin and Hawking were necessary, particularly in the phosphorylation experiments, in order to produce measurable changes, and in the comparative experiments with quinine the greater inhibitory action of 'Paludrine' was more marked at high than at low concentration. It may be, therefore, that inhibition of oxidative processes does not play such an important part where 'therapeutic' concentrations of the drug are concerned.

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Aug. 1.

[1] Tonkin, I. M., *Brit. J. Pharm.*, **1**, 163 (1946).
[2] Hawking, F., *Nature*, **159**, 409 (1947).
[3] Marshall, P. B., *Brit. J. Pharm.* (in the press).

β-Glucuronidase and Tissue Damage

AFTER repeated feeding of menthol to mice, Fishman[1] obtained results which on statistical examination showed an increase in β-glucuronidase in liver, spleen and kidney as compared with organs from untreated animals. Similar results were obtained in dogs fed with borneol. Since the compounds examined are known to be excreted as the glucuronides in certain species, Fishman considered β-glucuronidase to be responsible for glucuronide synthesis *in vivo*, and that he was measuring adaptation on the part of the enzyme in response to the presence of excess substrate. The work of other authors is not, however, compatible with the view that the function of β-glucuronidase in the body is other than hydrolytic[2,3,4].

Using biosynthetic phenol β-*d*-glucuronide[5] for the assay of glucuronidase[6], an attempt was made to confirm Fishman's findings with menthol. Twenty-four hours after intraperitoneal injection of *l*-menthol in vegetable oil into mice there was a marked rise in glucuronidase in liver, but not in kidney. It was difficult to decide whether the spleen enzyme was affected because of the great variation in normal values observed with this organ. Average normal values were the same in the case of each organ for mice of both sexes and drawn from three different colonies. The rise in liver glucuronidase was less marked after repeated feeding of menthol than after injection of much smaller doses.

It was observed that menthol caused gross damage to the liver, but not to the kidneys, and it was considered that this property, rather than the one of giving rise to a glucuronide, might explain the effect on liver glucuronidase. A variety of other substances, known to cause damage to the liver or kidneys, but with one exception unlikely to form glucuronides, were therefore examined for their effects on glucuronidase. Compounds which are relatively non-toxic, but which are known or considered to form glucuronides in the body, were also examined. The substances were injected subcutaneously or intraperitoneally in oil or aqueous solution into groups of 3–9 mice, and the animals were killed after 1–3 days. With several of the substances, the organs were examined histologically

Substance	Dose gm./kgm.	G.U.*/gm. moist tissue Spleen	Liver	Kidney	Histological findings
Normal mice	—	580	280	378	—
Liver poisons					
l-Menthol	0·33	777	933	285	Moderate fatty degeneration and necrosis of liver, with evidence of repair, all most marked with carbon tetrachloride. Little deviation from normal in kidney and spleen.
l-Menthol β-*d*-glucuronide	2·3	995	1104	295	
Carbon tetrachloride	5·33	840	1138	139	
Chloroform	2·0	1079	939	194	Not done.
Kidney poison					
Mercuric nitrate	0·02 to 0·04	718	469	808	Kidney was profoundly damaged, with marked necrosis in the medullary region and hyaline casts. Liver and spleen showed little change from normal.
Liver and kidney poisons					
Yellow phosphorus	0·0075	506	91	338	Marked fatty degeneration of liver with no signs of repair. Small areas of necrosis in kidney, most marked in cortex. Spleen as normal.
Phenyl arsenoxide†	0·001 to 0·002	807	257	471	Extensive fatty changes in liver with severe necrosis and no evidence of repair. Kidney as with phosphorus, but changes more obvious. Spleen as normal.
'Non-toxic' compounds					
Sulphathiazole	43	561	460	368	Not done
Pregnanediol‡	0·33	1001	287	321	
Pregnanediol‡ β-*d*-glucuronide	0·80	627	241	264	

* One G.U. (glucuronidase unit) liberates 1 μgm. phenol from 0·015*M* phenol glucuronide at 38° and *p*H 5·2.
† This compound could conceivably give rise to a glucuronide.
‡ Injected as a suspension in oil.

by Mr. J. G. Campbell of the Royal (Dick) Veterinary College, Edinburgh. As shown by the averaged results in the table above, a significant rise in the β-glucuronidase level only occurred when an organ showed obvious, but not irreparable, damage.

Phenylarsenoxide had no effect on the glucuronidase level in liver or kidney, while phosphorus actually depressed it in the case of liver. Both substances, however, caused extensive damage. These results favour the view that a rise in glucuronidase is associated with tissue regeneration following moderate damage rather than with the damage itself. A series of experiments is in progress to settle this point. The effects observed with menthol glucuronide were presumably due to liberation of menthol by glucuronidase initially present in the body, and are difficult to reconcile with Fishman's views. The rise in liver glucuronidase caused by carbon tetrachloride may to some extent explain its enhancing action on the effect of œstrogens[7], since glucuronide formation plays some part in the metabolism of the latter compounds. It is interesting to note that both carbon tetrachloride[8] and chloroform[9] are known to produce hepatomata after repeated administration to mice. The possibility of menthol behaving similarly is under investigation. In a recent communication to *Science*, Fishman[10] gives figures showing that in some cases of human carcinoma the tumour contained much more glucuronidase than the corresponding normal tissue. He suggests that this may be due to excessive local accumulation of œstrogens. In view of the bearing of our results on this finding, it was considered that an interim account should be published without further delay.

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The Sulphatase of Clarase

'CLARASE'*, an enzymatic preparation containing mainly amylase and in smaller amounts maltase, protease, peptidase, lipase and other enzymes, has now been shown to possess sulphatase activity. This sulphatase appears to be mainly phenolsulphatase. Other sulphatases (glucosulphatase[1], chondrosulphatase[2] and myrosinase[3]) from various sources have been described by different authors.

Conditions for the activity of sulphatase of 'Clarase' were examined; the optimum *p*H was found to be about 6.

Of the buffers used the *M*/7·5 phosphate was found to be most suitable. A slight inhibition was observed with acetate buffer and a very marked one with B.D.H. universal buffer.

The sulphatase of 'Clarase' hydrolyses the ethereal sulphates of horse urine, but not to such an extent as the takadiastase described by Noguchi[4]. Under comparable conditions only 24 per cent of the ethereal sulphates were hydrolysed as against 93 per cent reported by Noguchi. Contrary to the opinion of Noguchi, who ascribes the high percentage of hydrolysis to favourable conditions prevailing in horse urine, it was found that the sulphatase of 'Clarase' is actually inhibited by that medium, as is shown in the accompanying table:

INHIBITION OF SULPHATASE BY HORSE URINE

(Percentage hydrolyses of the ethereal sulphates of horse urine compared with those of potassium phenylsulphate in phosphate buffer; the concentrations of substrates expressed as SO_3 are equal.)

Time (days)	Control: Horse urine	Control: Phosphate buffer	2% 'Clarase': Horse urine	2% 'Clarase': Phosphate buffer	4% 'Clarase': Horse urine	4% 'Clarase': Phosphate buffer
1	0·6	0·8	20·0	53·2	41·2	72·0
3	1·2	2·6	23·4	55·4	44·4	84·9
5	1·4	3·2	24·4	60·2	47·0	93·0

(The chief ethereal sulphates found in horse urine besides potassium phenylsulphate, namely, indican and potassium-tolylsulphate, were shown to be hydrolysed by the sulphatase of takadiastase to approximately the same extent[5,6].)

Human urine was also proved to exert an inhibitory effect on the sulphatase of 'Clarase', though to a lesser degree.

It is possible that urea is the substance partially responsible for the inhibition by both horse and human urine, as in pure buffer solution it inhibits the activity of sulphatase; the degree of inhibition is dependent on the concentration of urea.

* Produced by Takamine Laboratory, Inc., Clifton, N.J.

When potassium phenylsulphate, which was used as substrate in the above experiments, is replaced by potassium dimethyl-phenylsulphate, a reduction in the rate of hydrolysis is observed. Hence introduction of aliphatic radicals into the benzene ring of potassium phenylsulphate seems to hinder the activity of the enzyme. This effect is still more marked when carvacryl (2-methyl-5-isopropyl) sulphate is used as substrate.

A fuller account of these investigations will be published shortly.

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Fructose and the Reducing Value of Insects' Blood

The reducing value of the blood or hæmolymph of insects is a very variable quantity, depending both on species and on the stage of the life-history[1,2]. However, all observations agree that the true blood sugar accounts for only a fraction, usually considerably less than 30 per cent, of the total reducing value. On the grounds that this fraction is yeast fermentable, and that in a few cases a glucosazone has been obtained, this sugar has been considered as glucose[3-4].

The total reducing value of the hæmolymph of the 3rd instar larva of the fly *Gastrophilus intestinalis*, parasitic in the stomach of the horse, averages 356 mgm. per cent, calculated as glucose; of this value the high figure of some 200 mgm. per cent or 60 per cent is fermentable by yeast and constitutes the reducing blood sugar. Previous workers[5,6] have suggested that glucose is present in the hæmolymph; but in view of the following evidence, the whole of the fermentable sugar may be accounted for by the content of fructose.

The deproteinized hæmolymph gives a strongly positive resorcinol (Seliwanoff) reaction and the glucosazone was isolated. Following the advice of Dr. D. J. Bell[7], the β-diacetone fructose compound was crystallized from a pooled blood sample. The melting point (uncorrected) was 94·5° C., while the mixed melting point obtained with a sample prepared from pure fructose was 94·2° C. Employing the quantitative method of Roe[8], I have found the fructose content of the blood to vary from 184 to 294 mgm. per cent.

If a blood sample be allowed to stand, fructolysis occurs spontaneously. In a blood sample allowed to stand for two hours at 37° C. the fructose content decreased by 14 per cent, while the blood lactic acid increased by 48 per cent. The fructose is almost entirely in the free, that is, non-phosphorylated state.

Adapting the Roe method for a qualitative as well as a quantitative test, no appreciable amounts of fructose were found in the blood of the adult locust (*Schistocerca* sp.), the larva of the wax moth (*Galleria mellonella*), or in the late third instar larva or adult of the blow-fly (*Calliphora erythrocephala*). Values found for the two stages of the latter species were 14 mgm. per cent and 5 mgm. per cent respectively.

Just prior to the onset of pupation, the reducing value of *Gastrophilus* blood rapidly increases to more than 500 mgm. per cent, although the fructose remains at its normal level. As pupation advances, the fructose content rapidly decreases, as shown in the following table:

Age of pupa, in days	1–2 (pre-pupa)	2–3	6–7	10–11
Total reducing value in mgm. %	375	196·5	186	202·5
Fructose content in mgm. %	171·2	100·5	31·6	21·7

Yeast fermentation tests have demonstrated that the whole of the fermentable sugar is still fructose, and that, therefore, by the tenth day of pupation, when the developing fly is externally almost fully formed, glucose has not increased at the expense of fructose.

It should be pointed out that these experiments were performed from March onwards, when the *Gastrophilus* larva is accumulating large stores of fat, and its glycogen reserves are being depleted[5,9]. The possible role of fructose in the intermediary metabolism of this change is to form the subject of further work.

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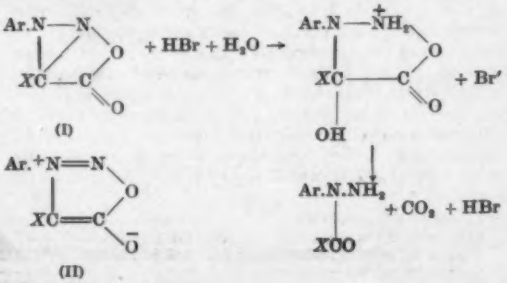
α-Acyl Hydrazines

The chemistry of α-alkylated arylhydrazines is familiar, but the corresponding α-acyl compounds have received no attention owing to their comparative inaccessibility. It will, however, now be possible to repair this deficiency as a result of our observation that salts of these compounds are produced together with carbon dioxide quantitatively at once when a solution of a sydnone in benzene is treated successively with a molecular proportion of water and of hydrogen chloride or bromide in ether[1]. We relate the extreme facility of this decomposition in its last stage to the benzidine change and formulate it as follows:



It would appear very difficult to interpret these facts in terms of the formula (II) considered in earlier correspondence[2], although this latter accords with other evidence and with the immediate reduction of potassium permanganate in acetone. On the other hand, we have not observed phenolic reactivity of N-phenyl sydnone towards aldehydes or coupling agents, and we conclude that the sydnones exhibit intra-annular tautomerism between structures I and II.

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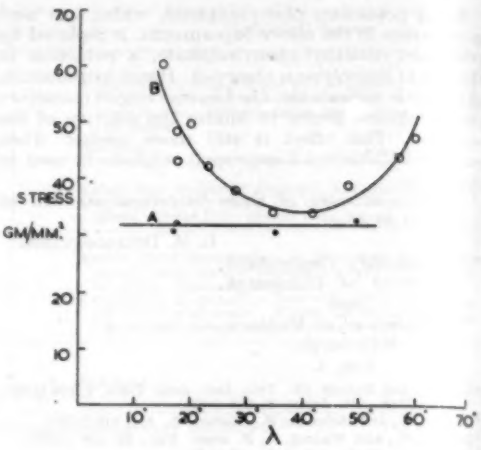
Thermal Hardening of Cadmium Crystals

THE phenomenon of thermal hardening was first observed by Orowan[1,2] in single crystals of chemically pure zinc. He noticed that, sometimes, zinc crystals, after resting for 24–48 hours at room temperature, showed no trace of plastic deformation with applied stresses as much as 30 per cent above the previously determined critical yield stress. The crystal might remain for several minutes under such a high load without yielding; then extension would suddenly occur, and the yield stress fall, almost immediately, to the normal value originally observed.

Recent work in this Laboratory with single crystals made from spectroscopically pure cadmium has shown that the phenomenon is not a rare one, but occurs with every crystal used. These cadmium crystals show appreciable hardening (increase of yield stress by 5 per cent over the previously determined yield stress) in times as short as 4–5 min. at room temperature. Preliminary experiments showed that, for the temperature range 20–100° C., the time of annealing necessary to produce a given degree of thermal hardening decreases by a factor of between 2 and 3 for every 10° C. rise in temperature, and even with those crystals slowest to harden (see below) the process was always complete after annealing at 200° C. for 30 min. After this treatment the yield stress had been raised to a limiting maximum value, and this was therefore adopted as standard treatment in later experiments.

Two other factors were also found to influence markedly the rate of thermal hardening, namely, orientation and pre-straining of the crystal. The period of annealing was found to be a maximum for crystals where λ (the angle between the direction of the applied stress and the glide direction) lay between 30° and 50°. These figures could not be determined very accurately. The period of annealing was also found to increase rapidly with the amount of pre-strain impressed on the crystal, as is shown by the following figures. The 'hardening time' is the time needed, at room temperature, for the yield stress to rise 5 per cent above the previously determined critical shear stress.

Hardening time	Pre-strain
5 min.	0·1 per cent
40 "	3·8 "
140 "	11·0 "



After this preliminary work, further experiments were performed to determine how the value of the 'raised' yield stress varied with the orientation of the crystal, the annealing conditions being constant, that is, 200° C. for 30 min., and then cooling to room temperature, at which temperature the yield stress was determined.

The accompanying graph shows the variation, with orientation, of both the normal yield stress in shear (curve *A*), and also the 'raised' yield stress (curve *B*), for spectroscopically pure cadmium (99·999 per cent Hilger H.S. specification). As is to be expected, the normal yield stress is constant at 32 ± 1 gm./per mm.[2]. The yield stress has also been determined for 'chemically pure' cadmium and found to be 60 ± 1 gm./mm.[2]. These results are in good agreement with those of Andrade and Roscoe[3], who give corresponding values of 26 gm./mm.[2] and 56 gm./mm.[2]. The effect of very small amounts of impurity on the value of the critical shear stress has also been reported by Dehlinger and Gisen[4], who found that, in changing from 99·87 to 99·98 per cent aluminium, the yield stress falls from 145 gm./mm.[2] to 85 gm./mm.[2].

The curves also show the striking fact that the magnitude of the thermal hardening is a minimum for crystals with the glide direction at an angle λ between 40° and 45° to the axis of the wire, and that with these crystals it is approximately zero. For angles of orientation on each side of the minimum, the 'raised' yield stress rises rapidly, the maximum so far observed being approximately 70 per cent above the normal value.

If it is assumed[1] that thermal hardening is due to the movement of dislocations out of the crystal or into positions where they cannot be moved easily by the applied stress, the effects of temperature, pre-strain, and impurities are easily understood. At higher temperatures, the movement of dislocations takes place more rapidly; greater pre-strain produces a higher density of dislocations which, by their mutual interaction, impede each other's movement[5]; and the presence of impurities leads to internal stresses which act as barriers to the movement of the dislocations and slows down the process of their elimination. The new fact of the dependence of thermal hardening on the orientation of the crystal, however, does not seem to be explicable on such general assumptions.

I would like to thank Dr. E. Orowan for helpful discussions, and the British Iron and Steel Research Association, under the auspices of which the work was done, for permission to publish this paper.

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Surface Tension and Detergency

THE surface tension of an aqueous solution has long been recognized as one of the more important physical properties controlling its wetting and detergent powers, though early attempts to correlate these powers with equilibrium surface tension met with limited success. It is becoming generally appreciated that factors other than solute concentration influence surface tension, and that the condition of the surface must also be taken into account. Thus, the surface age involved in many detergent processes does not exceed a few seconds, and much of this time may be required for the establishment of diffusion equilibrium. For dilute solutions of long-chain compounds the operative dynamic tension may vary over a range of 40 dynes/cm., and acknowledgment of the time required for surface equilibrium is clearly essential. A further factor, the change in equilibrium surface tension which occurs during change in area of a soluble film, has not previously been considered, but may prove to have considerable significance.

In very dilute solutions, the decrease in tension is proportional to solute concentration, and the Gibbs adsorption equation simplifies to the linear $\gamma - \Gamma$ relation $\gamma = \gamma_0 - RT\Gamma$ typical of a gaseous film. Lateral cohesion, or repulsion between adsorbed molecules at higher concentrations, necessitates the introduction of correction factors; but these direct equations imply that the surface tension is dependent only on the surface excess Γ so long as the surface is stationary (that is, of constant area). However, recent experiments[1] have shown that the surface tension equivalent to a given surface excess per unit area of a long-chain adsorbate may be varied by as much as 10 dynes/cm. during expansion of the surface. If the adsorbed carbon chain is sufficiently long, the distribution of the forces between molecules at or near the surface (and thus the free surface energy) will depend upon the mean position of orientation of the adsorbed molecules. This orientation is likely to differ at stationary and expanding surfaces, and it is significant that the expansion effect is not apparent for short-chain solutes. Again, on contraction of a soluble film the migration of long-chain molecules away from the surface appears to take an appreciable time, so that a fresh contracting surface may contain an amount of adsorbed material in excess of the equilibrium amount.

Therefore, the surface tension of a solution, previously regarded as a function of bulk concentration and time only, must now be considered as subject to changes in area also, and the possible types of air–water interface may be subdivided as follows:

Dynamic stationary (1) → Equilibrium stationary (2) → Aged stationary (3)

Dynamic expanding (4)

Equilibrium expanding (5)

Dynamic contracting (6) → Equilibrium contracting (7).

The term 'dynamic' is restricted, as already suggested in *Nature*[2], to surfaces at which the initial surface excess is in the process of accumulating. The term 'equilibrium' implies that the initial diffusion required in the accumulation of the surface excess has been completed, though secondary diffusion processes resulting from changes in surface area may still be operative. Arrows indicate those surface types which pass from one to another with time; (4) can only pass into (5) by increasing the solute concentration. A similar range of surface types exists for liquid–liquid interfaces, though (3) is not well characterized.

The fresh surfaces operative in detergent processes are frequently expanding or contracting, and may fall into any one, or several, of the above types (except (3)). For a given solution, the surface tensions corresponding to these different surface types vary widely, and it appears essential that the type of surface involved should be determined before any successful correlation between surface tension and detergent power can be achieved.

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Optical Rotatory Power and Atomic Dimension

IN a recent paper by Brauns[1], an attempt is made to relate the differences in optical rotatory power of the respective alkyl halides and the differences in atomic dimensions of the halogens. The ratio of differences in specific rotation (*D* line) of the 2-halogenopentanes were found to be (Br, 41·6 − 42·6, Cl) : (I, 46·68 − 41·6, Br), that is, − 0·86 : + 5·08. Atomic dimension differences require (Br − Cl) : (I − Br) = 17·1 : 21·4, and on this basis the bromide should have a larger rotation than the chloride.

Whereas previous observations[2] mentioned by Brauns had led to the conclusion that 2-chloro-octane, $[\alpha]_D^{20°}$ 35·8°, had a higher rotation than the bromide (best estimated maximum, $[\alpha]_D^{20°}$ 33·8°), he now obtains 2-bromo-octane having $[\alpha]_D^{20°}$ 40·6°, and providing a ratio of 17·1 : 30·3 for (Br − Cl) : (I − Br). In this observation he was preceded by Gerrard[3].

This question of maximum rotation of halides becomes even more interesting in the example of phenylmethylcarbinol. Whereas $[\alpha]_D$ 50·6° for 1-chloro-1-phenylethane[4] was for some time accepted as being near the maximum rotation, the rotatory power of the bromide being even less than this, Gerrard[5] obtained a specimen of the chloride having $[\alpha]_D^{16°}$ 93·5°, by the interaction of the carbinol and phosphorus oxychloride in the presence of pyridine, and the bromide having $\alpha_D^{18°}$ 131·4° ($l = 1$) by means of phosphorus tribromide and pyridine.

In a further examination of this subject, we are employing phosphorus oxybromide, the uses of which, in organic chemistry, do not appear to have been investigated. This reagent in the presence of pyridine gave rise to 1-bromo-1-phenylethane with $\alpha_D^{17°} + 125{\cdot}2°$ ($l = 1$), from *R*OH, $\alpha_D - 44{\cdot}0°$, and 1-bromo-1-phenylpropane with $\alpha_D^{16°} + 174{\cdot}2°$ ($l = 1$), from *R*OH, $\alpha_D^{16°} - 26{\cdot}4°$.

From the flattening of their rotation – reaction-temperature curves, Levene and Rothen[4] conclude that the maximum values of the molecular rotations of these bromides are respectively $[M]_D$ 90° and $[M]_D$ 140° (in benzene). Since Arcus[7] used these values to represent the experimental curves of Levene and Rothen in terms of percentage optical purity and the contributions of stated mechanisms to the rotation of the product obtained at the different temperatures, and since our values for [*M*] (benzene) are nearly twice these, it follows that Arcus' curves and argument should be reconsidered.

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Preparation of Colourless Carborundum

In a paper to Section I of the Eleventh International Congress of Pure and Applied Chemistry, J. T. Kendall and D. Yeo described the preparation of pure silicon carbide by passing the vapours of silicon-organic compounds over a heated carbon filament; the product they obtained was bright yellow in colour and it was not found possible to prepare colourless specimens by this method. On theoretical grounds it would be expected that pure silicon carbide should be colourless and, according to H. Moissan[1], carborundum free from traces of iron is without colour; he obtained almost colourless, prismatic needles of carbon silicide by allowing the vapours of carbon and silicon to react with one another. In view of current ideas on the part played by impurities in determining the electrical properties of semi-conductors, it is of interest to record another and simpler method by which colourless carborundum can be prepared.

The following observations were made during a study of the deposition of carbon from the gas phase on fused silica. The experiments were carried out in a long vitreosil tube 0·8 in. internal diameter, heated electrically. Inside this tube was another vitreosil tube, 6 in. long, 0·4 in. internal and 0·6 in. external diameter, provided with lugs so that an annulus was left between the two tubes. The temperature was measured by means of a Pt/PtRh thermocouple, surrounded by a vitreosil sheath, situated axially in the tube. Ethylene, saturated with water vapour, was passed through this apparatus heated to 1,200° C. at a constant rate of twenty-five litres (measured at room temperature) an hour. In one experiment, which had lasted several hours, in addition to the carbon deposit there was formed on the centre part of the outer surface of the inner silica tube a white, fluffy, mould-like growth. An X-ray powder photograph showed this to be cubic carborundum; although only microcrystalline, the back reflexions in the powder photograph were sharp and resolved. In appearance it was quite unlike the greenish-yellow cubic variety formed when carbon reacts with silica at higher temperatures; it had a soft texture and readily gave an extruded rod for X-ray examination when mixed with a little dilute gum arabic solution. First attempts to repeat this preparation were unsuccessful, possibly because the surface of the silica tube must be in a specially active condition. At a somewhat higher temperature (1,300° C.), however, it was found possible to repeat the formation of this white form of cubic carborundum.

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A Volatile Compound of Copper

Kőrősy[1] has recently reported that copper formate decomposes when heated, evolving a small amount of a volatile copper compound. I encountered a similar phenomenon when gently igniting a deposit from a copper rectifying column, the deposit containing cupric acetate. According to Angel and Harcourt[2] the formation of a white sublimate of cuprous acetate on heating cupric acetate was first observed so long ago as 1773 by Lassone[3]. The formation of such volatile compounds may result in low values for the copper content of such materials as vinegar when dry-ashing methods are used in their analysis.

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A Crystalline Principle from *Ammi majus* L.

Ammi majus L.[1] (Umbelliferæ) is an annual herbaceous plant which is widely spread in the Nile delta region and closely resembles *Ammi visnaga* L. The fruits of *Ammi majus* are taken internally by the public to cure leukoderma.

The powdered fruits of *Ammi majus*, collected in May, were extracted by hot petroleum ether (b.p. 60–70°) and the extract kept in the ice chest overnight, when a crystalline greenish mass separated, from which a colourless crystalline principle m.p. 148° was isolated, and for which the name 'ammoidin' is proposed (I. R. F. and H. A.). The crystalline substance was investigated chemically (A. S. and A. S.). It is easily soluble in chloroform and benzol, and

contains neither active hydrogen nor acetyl group. The methoxyl test is positive and the substance does not react with diazomethane. It seems not impossible that the substance is related to 'kellin'[1], which is used in the treatment of angina and bronchial asthma[2].

Further work from the pharmacognostical and chemical sides is in progress.

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[1] Fahmy, I. R., and El-Kely, M., *Rep. Pharmaceut. Soc. Egypt*, **3**, 72 (1931).
[2] Spaeth, E., and Gruber, W., *Ber.*, **71**, 106 (1938).
[3] Anrep, G. V., Barsoum, G. S., Kenawy, M. R., and Misrahy G., *Lancet*, **1**, 557 (1947).

An Apparatus for Preparative Electrophoresis

A considerable number of suggestions have been made[1] of arrangements for the separation of ionized substances of different mobilities in an electric field, involving, for example, (1) diaphragm cells with three or more compartments[2], (2) a series of beakers connected by inverted U-tubes[3], (3) tubes filled with sintered glass[4], (4) slabs of silica gel[5], (5) modifications of the Tiselius apparatus which permit the withdrawal of liquid from any section of the advancing front[6].

(1) and (2) suffer from the disadvantage that convective and electro-endosmotic streaming occur in the compartments, so that the useful separative process is confined to the membranes or narrow tubes; (3) has an unduly high resistance; (4) has been successfully employed for comparatively small peptides. It is anticipated that the gel may hinder the free migration of larger molecules; and the problems of detection within the jelly and separation from it become formidable when only a few milligrams of material are available. The Tiselius apparatus is essentially one for the analysis of the moving fronts, and though samples can be withdrawn for analysis, it does not permit a complete separation of the components of a mixture.

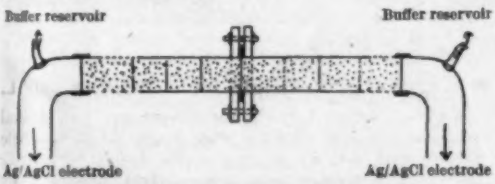

Fig. 1. Preparative electrophoresis apparatus

After a number of trials of other types, we have developed a simple apparatus which gives satisfactory results so far as it has been tested (Fig. 1). Migration is made to occur down a tube of thin polystyrene plastic material, about an inch in diameter and a metre long, which is fairly loosely filled with asbestos fibre of the type usually used in Gooch crucibles. This does not greatly increase the resistance of the column when filled with the buffer solution, and effectively prevents convective spreading. The asbestos is divided into sections by filter paper barriers at 1-inch intervals. These permit the wads of asbestos to be separated with ease when removed from the tubes. The tube is divided into two halves, fitted with plastic end-pieces, which enable them to be clamped together, making with a rubber washer a water-tight junction. The tube can be divided into as many sections as may be convenient, and sections can be removed or added during the electrolysis without disturbing the remainder. The tube is cooled by a water sprinkler placed above it.

The solution to be examined (about 5 c.c. in this apparatus) is mopped up with dry asbestos and introduced into the tube at the middle join. It is important that the solution and the buffer present in the rest of the column should be at the same *p*H and have approximately equal specific conductances; otherwise migration anomalies occur. The electrodes are of silver – silver chloride in concentrated sodium chloride similar to those used with the Tiselius apparatus. They are completely closed, so that no transport of the solvent occurs through the column.

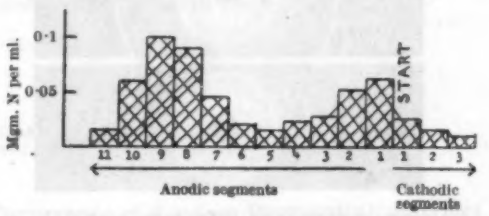

Fig. 2. Electrophoretic separation of glycine and glycylglycine at *p*H 9·3

In tests with coloured substances such as dinitrophenylglycine and coloured indicators it was found that the asbestos effectively prevents the convective dispersion of the coloured ions, which move down the tube without undue spreading. The asbestos wads are blown out of the tube by air pressure or pulled out by tongs after the experiment. It is a simple matter to squeeze the liquid contents of each segment into a test tube for analysis. Fig. 2 shows the analysis of the segments after electrolysis of a mixture of glycine and glycylglycine at *p*H 9·3 for 24 hours with a potential difference of 250 volts between the electrodes (approximately 2 volts per cm. in tube). It is clear that a good separation has been obtained, the fraction which has migrated towards the anode at this *p*H being glycylglycine. A more detailed account will be given elsewhere.

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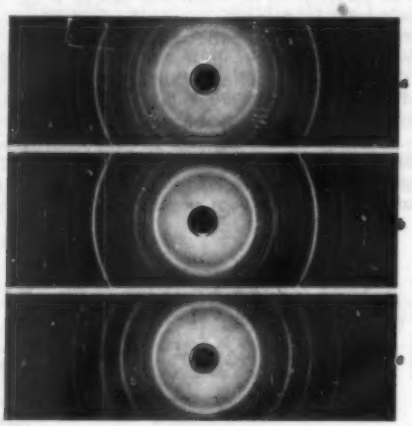
July 29.

[1] For review, see Martin, A. J. P., and Synge, R. L. M., in "Advances in Protein Chemistry", Vol. II (1945).
[2] For example, Gordon, A. H., Martin, A. J. P., and Synge, R. L. M., *Biochem. J.*, **35**, 1369 (1941); **37**, 92 (1943).
[3] du Vigneaud, V., Irving, Dyer and Sealock, *J. Biol. Chem.*, **123**, 45, 485 (1938); *J. Amer. Chem. Soc.*, **63**, 503 (1941). See also Williams and Truesdail, *ibid.*, **53**, 4171 (1931); **55**, 2912 (1933).
[4] Coolidge, T. B., *J. Biol. Chem.*, **127**, 551 (1939).
[5] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **40**, 33 (1946).
[6] Theorell, H., *Biochem. Z.*, **275**, 1 (1934). Svensson, H., *Arkiv. för Kemi, Min. o. Geol.*, **22A**, No. 10 (1946). Bunn, D., *Proc. Biochem. Soc.*, **41**, 24 (1947).

Identification of a Calculus from a Hippopotamus

DURING a recent visit to Nairobi, one of us (K. P. O.) secured, for purposes of determination, a fragment of a brown calculus of rather unusual origin which is preserved in the Kenya Game Department. Captain A. T. A. Ritchie, chief game warden, said that according to report this 'stone' was found in a hippopotamus killed on the Tana River some years ago. It was cut out of the animal by a native skinner, whose employer had passed it to Captain Ritchie. The location of the calculus in the animal was not recorded.



X-RAY POWDER PHOTOGRAPHS OF (*a*), ARTIFICIALLY PREPARED $CaC_2O_4.2H_2O$; *b*, POWDERED HIPPOPOTAMUS CALCULUS, $CaC_2O_4.2H_2O$; *c*, WHEWELLITE, BURGK, DRESDEN, SAXONY

The 'stone' is a flattened irregular ovoid with a smooth surface and, according to Mrs. M. D. Leakey, originally measured about 8 cm. × 6 cm. × 4 cm. It has been broken away on one side to a depth of nearly a centimetre, revealing a concentrically laminated structure and an apparently uniform composition. The fragment brought back to England is made up of concentric zones not more than 10 μ thick and readily cleaves into layers about 1 mm. thick. Chemical tests and X-ray powder photographs show that it is identical with tetragonal hydrated calcium oxalate, $CaC_2O_4.2H_2O$ [*a* 12·40, *c* 7·37 A.][1], and not with whewellite, the monoclinic monohydrate. Examination in polarized light reveals a minutely fibrous structure with fibre axis perpendicular to the plane of zoning, and X-ray diffraction photographs of stationary sections confirm that the fibre axis is *c* [001] but reveal that the orientation of the fibres across the plane of zoning is far from perfect. Moreover, there is no orientation of the [100] axes in the plane of zoning. The optical examination and X-ray photographs show that the layers are uniform in composition and crystal size, the length of each fibre not exceeding 10 μ and the cross-section being of the order of 1 μ.

Tetragonal calcium oxalate (weddellite) is very rare as a mineral but has been reported by two of us (F. A. B., M. H. H.) from one locality in the very deep water of the Weddell Sea, and its occurrence as minute 'envelope' crystals in plants and human urine is well known. Renal calculi from the human bladder are, however, usually of mixed composition, and those examined by us in 1936 were essentially fine-grained calcium carbonate-phosphate, similar to the mineral dahllite (carbonate-apatite), studded with large crystals (2–3 mm. across) of tetragonal calcium oxalate.

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[1] Bannister, F. A., and Hey, M. H. Report on some crystalline components of the Weddell Sea deposits. *Discovery Rep.*, **13**, 49 (1936).

Structures Produced in Clays by Electric Potentials and their Relation to Natural Structures

IF an electric potential is applied by means of two electrodes to a remoulded soil containing a proportion of particles of colloidal size, such as London clay, the soil develops a structure which is similar in appearance to that of the clay in its natural state. This phenomenon was observed by me in 1931 on a great variety of fine-grained soils. In recent investigations carried out on London clay and Wyoming bentonite, I found that the electro-osmotic transport of pore water towards the cathode results in the formation of cracks in the soil around and between the electrodes, the pattern of the cracks following the equipotential lines. These cracks, which are filled with free water, become more widely spaced with increasing distance from point electrodes. Originating from these basic cracks an irregular pattern of additional fissures is formed. When the soil becomes consolidated, as, for example, by continued electro-osmotic drainage or drying, the fissures

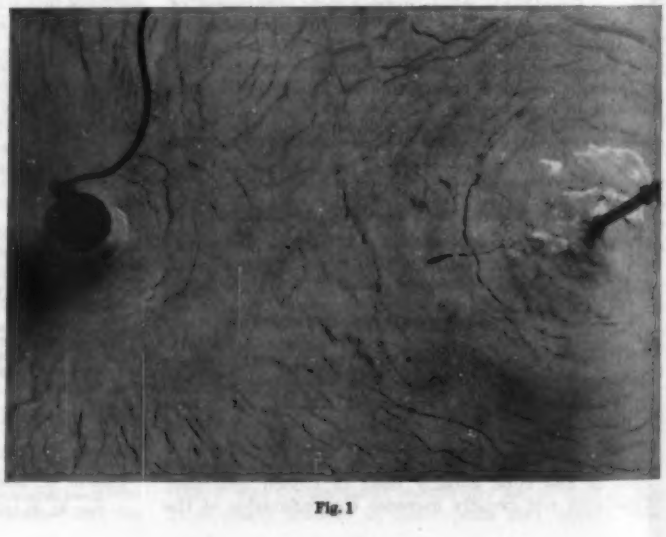

Fig. 1

Fig. 2

and cracks close up but the structure remains even in the completely dry state and is readily revealed on breaking up the soil. Fig. 1 shows such a pattern in a gel of 2 per cent by dry weight of Wyoming bentonite, after a potential gradient of 0·2 volts per cm. was applied for forty hours. Surrounding the copper cathode (the thick electrode) concentric fissures in the process of formation can be seen.

Fig. 2 shows the laminated structure produced in a sample of what was originally uniformly remoulded London clay after treatment with a potential of 0·5 volt per cm. over a period of three months. The laminations follow the equipotential surfaces.

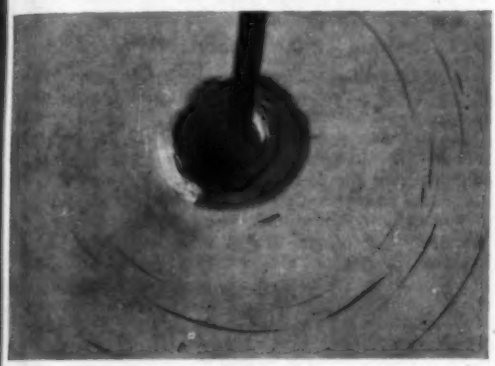

Fig. 3

Apart from the visible laminations in Fig. 2 the sample exhibits a random fissured structure with polished walls similar in appearance to the well-known fissures found in most old natural clays, for example, London clay, which were laid down by sedimentation. The greater the colloidal content of the soil, the more distinctly are the fissures developed, and this seems to conform to Nature where the more colloidal clays generally exhibit better developed fissures.

While the spaces between the individual laminations (equipotential lines) are similar at both electrodes, visible cracks do not always appear at the anode. Differences arise from the use of different metal anodes.

When an iron anode is used, an equipotential pattern of brown colour tones is produced from the anode, and with an aluminium anode in a bentonite suspension a practically colourless pattern develops, which may be seen in the form of slight ripples when the surface of the bentonite is viewed obliquely.

Under the microscope fine cracks forming an equipotential pattern are visible. Without exception, the anodic pattern (Fig. 3) resembles the well-known phenomenon of Liesegang rings[1].

It will be recalled that Liesegang in his experiments noticed that there was a marked concentration of water ahead of his rings. I have checked in a number of tests that the formation of Liesegang rings is associated with a considerable transport of pore water from the spot centre. The similarity between this and the anodic action in an external field suggests that the periodicity of precipitation may be conditioned by the development of cracks in the gel.

I feel that the concept of a water movement similar to the electro-osmosis arising from anodic action may have a useful application in connexion with many of the unsolved problems associated with the phenomena of rhythmic ring formation such as those which occur in flint and agate, and possibly in the pathological growth of concretions in man and animals.

The similarity between the laminations of Fig. 2 and those found in certain clay deposits, for example, varved clays, suggests an alternative explanation of the formation of varves to that given by De Geer[2] and his collaborators and pupils. The electric streaming potential originating from the natural consolidation of clay during deposition, or potentials arising from other external sources, could, it is suggested, produce laminations in clay in a similar way to those produced artificially in the laboratory.

This letter is published by permission of the Director of Building Research.

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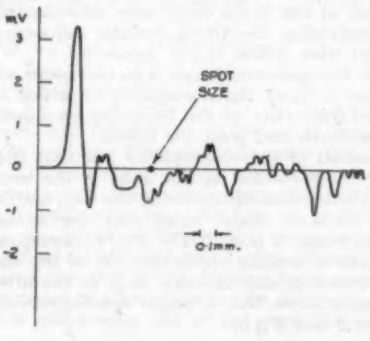
July 29.

[1] Liesegang, R. E., *Phot. Archiv.*, **21**, 221 (1896).
[2] Geer, G. De, "Geochronologia Suecia: Principles" (1940).

Occurrence of Random Photovoltaic Barriers in Photoconductive Layers

IN two previous communications[1,2] the photoconductive properties of lead sulphide layers and a new photovoltaic effect were described. The latter effect is essentially a property of the semi-conductor and is not associated with the electrodes. A theory of the effect was outlined which attributed the photo-e.m.f. to the barrier between regions of excess and defect semi-conductors. It was further postulated that, in an apparently homogeneous photoconductive layer showing no external photo-e.m.f., there existed regions distributed at random which were predominantly either excess or defect semi-conductors. The photoconductive properties of the layer were also attributed to the barriers between these regions. Experimental evidence has now been obtained to justify this assumption.

Photoconductive layers have been scanned by a small spot of light, 30 microns in diameter, formed



by focusing, with a microscope objective, an image of a two-watt Western Union concentrated arc source. The photo-e.m.f. was measured using an electrometer triode. In every case a photo-e.m.f. was observed varying in magnitude and sign from point to point of the layer. The accompanying figure shows the typical variations for 2 mm. of a photoconductive layer of lead sulphide of about 1 micron thickness and 20 × 1 mm. area.

Since the theory is applicable to any substance which may exist as an excess and defect semiconductor, it was thought that the presence of photovoltaic barriers should be observed in photoconductive layers of substances other than lead sulphide. We are able to report preliminary results on layers of selenium which support the above conclusions. The photovoltaic effects observed in this case show, in general, the same magnitude and type of variation as those described for lead sulphide layers.

We have to thank Mr. J. S. Preston, of the National Physical Laboratory, for the preparation of the layers of selenium.

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[1] Starkiewicz, J., Sosnowski, L., and Simpson, O., *Nature*, **158**, 28 (1946).
[2] Sosnowski, L., Starkiewicz, J., and Simpson, O., *Nature*, **159**, 818 (1947).

Radiant Temperatures of Walls in North–South and East–West Rooms

In an investigation of indoor climate conditions initiated by the Indoor Climate Committee of the Meteorological Research Council in Palestine in the autumn of 1946 the mean radiant temperatures of walls of dwelling-rooms were (among other factors of the indoor climate) measured by means of the globe thermometer of Vernon. The observations were taken in two newly built houses of similar design, building materials, etc. The only difference between the two houses was in the orientation of the main fronts (longer walls): the main fronts of one house faced north and south, while those of the second one faced east and west. The actual observations were taken on the first floors of these (three-storied) houses. To be more precise:

(1) In the north–south house in a south room, whereby we mean a room (*a*) with a window on its south side; (*b*) communicating on its north side to another room with a window opening to north (the door between the two rooms was kept open during the whole period of observations); (*c*) on the east and west of the room there were other apartments, thus eliminating the direct climatic influence of the east and west fronts of the house.

(2) In the east–west house in an east room, whereby we mean a room the description of which will be obtained from that of the foregoing by substituting east for south and west for north.

The result of the observations was that the mean radiant temperatures of the walls in the east room have a double maximum during the day, one between 9 and 10 a.m. (local time) and the second one between 5 and 6 p.m. This would correspond to a maximum of irradiation by the sun of the east wall in the morning and the west wall in the afternoon. The south room has a single maximum occurring between 2 and 3 p.m.

The morning radiant temperature maximum of the walls in the east room is about 2½° C., the afternoon maximum about 1½° C. higher than the instantaneous value of the mean radiant temperature in the south room. On the other hand, the single maximum in the south room is not above the instantaneous value in the east room. The mean radiant temperature of the south room is always below that of the east room.

If the windows be kept shut during the day, the room air temperature in the east room will have a slight local maximum at about 10 a.m. (the observations were taken at the height 1·20 m. above floor), followed by a decrease, and afterwards a fresh and more gradual rise to the afternoon maximum.

The significance of the above is clear for the better orientation of houses in a country with a long and warm summer—a thesis that has been advocated by the above Committee.

I am indebted to the Committee for permission to publish this note.

J. Neumann

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Jerusalem.
Aug. 1.

Technique of the Analysis of Variance

I am afraid I disagree with Dr. Vajda's comments[1] on the analysis of variance technique appropriate to two-way tables with unequal frequencies in the different sub-classes. As I pointed out in the paper referred to[2], the expressions for the efficient estimates of the 'main' effects of the two variables are different according as interactions are assumed to exist or not. If interaction is assumed, the efficient estimate for the first variable in a 2 × 2 table, using Vajda's notation, is

$$a_1 = \tfrac{1}{2}\{(x_{11} - x_{21}) + (x_{12} - x_{22})\}.$$

If there is no interaction, it is

$$a_2 = \left\{\frac{n_{11}n_{21}}{n_{11}+n_{21}}(x_{11}-x_{21}) + \frac{n_{12}n_{22}}{n_{12}+n_{22}}(x_{12}-x_{22})\right\} \Big/ \left(\frac{n_{11}n_{21}}{n_{11}+n_{21}} + \frac{n_{12}n_{22}}{n_{12}+n_{22}}\right).$$

It is this latter expression that I derived by the method of fitting constants. (In the case of a 2 × 2 table it can, in fact, be written down directly by considering the variances of $x_{11} - x_{21}$ and $x_{12} - x_{22}$.) The expression for a_1 can, of course, also be derived by fitting constants, including a constant for interaction, though its form is obvious.

If all the sub-class frequencies are equal, the two estimates are identical, and this accounts for the formal simplicity of the analysis of tables with equal sub-class frequencies.

Snedecor[3] made an important further contribution to the subject when he pointed out that this formal simplicity is retained in the case of tables with proportionate sub-class frequencies ($n_{ij} = u_i v_j$), provided the main effect of each variable is re-defined as its average effect over the frequencies actually observed of the other variable instead of its average over equal frequencies of the other variable. In this case the estimate of the first variable is

$$a_3 = \frac{v_1}{v_1+v_2}(x_{11}-x_{21}) + \frac{v_2}{v_1+v_2}(x_{12}-x_{22}).$$

It will be noted that a_3 is identical with a_2 when the frequencies are proportionate.

The practical importance of this is that in the frequently occurring case when the observed frequencies, though very unequal, are nearly proportionate, an analysis can be made by the substitution of proportionate frequencies. This will not do any violence to the data, and will result in an immense reduction in computational labour. The estimates of the main effects so obtained are the same whether interactions exist or not; and, if interactions cannot be assumed negligible, are considerably more precise than those (a_1 above) obtained with the alternative definition of main effects.

There is consequently no logical inconsistency in the use of proportionate frequencies. If interactions exist, the magnitude of the main effects depends on the way in which they are defined, and the statistician must, of course, be clear what is implied. Inasmuch as the frequencies actually obtained are likely to be similar to those generally occurring in the type of material under consideration, the definition of the main effects implied by the use of proportionate frequencies is usually more appropriate in practice than that based on equal frequencies.

In conclusion, it may be noted that Dr. Vajda's first expression for the mean square gives the test of significance for a_1. His second expression gives the test of significance for a_2 (or a_3) when the frequencies are, in fact, proportionate; but in the more general form in which he has given it, it gives the test of significance for the estimate that would be obtained when the effect of the other variable and its interaction were both assumed negligible. It therefore has no relevance to the present argument.

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July 18.

[1] Vajda, S., *Nature*, **160**, 27 (1947).
[2] Yates, F., *J. Amer. Stat. Assoc.*, **29**, 51 (1934).
[3] Snedecor, G. W., *J. Amer. Stat. Assoc.*, **29**, 389 (1934).

Nomogram for the Tetrachoric Correlation Coefficient

ONE of the most frequently used measures of association in psychology, and even in other biological sciences, is the tetrachoric correlation coefficient. Unfortunately, the computing of r_{tet} from the standard formula is extremely laborious, and the value of some aid to this end has been recognized from the earliest days. This has become more important than ever, when correlations are prepared in hundreds for one factor analysis. The earliest of the devices for computing measures of association is the *ABAC* of Burt, which consists of a family of curves on one graph[1]. Vernon has four such graphs[2]. The best known of such aids are the computing diagrams of Thurstone[3]. There are forty-six such diagrams, each consisting of a family of curves. They are quite simple to read when working to two decimal places; but this can lead to considerable inaccuracy, and three places involves interpolating between two diagrams, with four readings each, a very time-consuming procedure.

It was considered desirable to attempt the construction of a nomogram for the tetrachoric correlation coefficient, which would have the advantage of being easy to read, and of being contained in only one diagram.

The equation for the true coefficient is impracticable for this purpose, but it was found that the empirical formula developed by Karl Pearson was eminently satisfactory[4]. This is $r_{tet} = \sin\left(\frac{\pi}{2} \cdot \frac{\sqrt{ad} - \sqrt{bc}}{\sqrt{ad} + \sqrt{bc}}\right)$,

b	a	$a+b$
d	c	$c+d$
$b+d$	$a+c$	N

where a, b, c and d are the cell frequencies. This converts into $r = \cos\left(\pi \cdot \frac{\sqrt{bc}}{\sqrt{ad} + \sqrt{bc}}\right)$. If r is read in degrees (and appropriately scaled in the nomogram), the formula can be manipulated into $\sqrt{ad} = \sqrt{bc} \cdot \left(\frac{180 - r^\circ}{r^\circ}\right)$.

It is impossible to design a nomogram if the cell frequencies are kept in their original state, or converted into probabilities totalling unity. If, however, the cell frequencies are divided by one of them, for example, c, the equation becomes $\sqrt{AD} = \sqrt{B} \cdot \left(\frac{180 - r^\circ}{r^\circ}\right)$, where $A = a/c$, $B = b/c$, $D = d/c$ and $C = c/c = 1$. This eliminates the non-independent variable in the only way suitable for the present purpose.

This equation can be used for the construction of a nomogram in two ways. Taking logarithms:

$$\log A + \log D = \log B + 2 \cdot \log\left(\frac{180 - r}{r}\right),$$

from which the two following determinants are obtained:

$$\begin{vmatrix} -1 & \log A & 1 \\ 0 & \frac{1}{2}R & 1 \\ 1 & \log D & 1 \end{vmatrix} = 0 \qquad \begin{vmatrix} -1 & \log B & 1 \\ 0 & \frac{1}{2}R & 1 \\ 1 & 2\log\left(\frac{180-r}{r}\right) & 1 \end{vmatrix} = 0$$

where R stands for a reference line

This nomogram consists of three parallel lines, the first being a logarithmic scale for A and D, the third a logarithmic scale of the same size for D, and of twice the size for $\left(\frac{180 - r}{r}\right)$, which is then re-scaled for cos r°, and the second is a reference line halfway between. To read it, a line is drawn between A and D, and the point of intersection with the reference line joined to B and prolonged to r.

A more compact nomogram in the shape of a circle can be constructed by deriving from the equation as it stands the two determinants

$$\begin{vmatrix} \frac{A}{A+1} & \frac{\sqrt{A}}{A+1} & 1 \\ \frac{1}{1+R^2} & \frac{-R}{1+R^2} & 1 \\ \frac{1}{1+\sqrt{B}} & 0 & 1 \end{vmatrix} = 0 \qquad \begin{vmatrix} \frac{B}{B+1} & \frac{\sqrt{B}}{B+1} & 1 \\ \frac{1}{1+R^2} & \frac{-R}{1+R^2} & 1 \\ \frac{r}{180} & 0 & 1 \end{vmatrix} = 0$$

The upper half of the circumference is scaled for A and B, and the horizontal diameter for D and cos r°. The lower half of the circumference forms the reference line. The nomogram is read by joining A and D and prolonging the line to the circumference; the point of intersection is joined to B, and r read off. There are other ways of reading the nomograms, but this is the simplest for routine use. Other varieties of nomogram can be designed, if this method of eliminating one of the variables is used,

for example, hexagonal and polar, but the two described are the simplest in use.

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[1] Burt, Sir Cyril, "Mental and Scholastic Tests" (1921).
[2] Vernon, P. E., "Admiralty Notes" (1944).
[3] Thurstone, L. L., Chesire, L., and Saffir, M., "Computing Diagrams for the Tetrachoric Correlation Coefficient" (1933).
[4] Pearson, K., "On the Correlation of Characters not Quantitatively Measurable", *Proc. Roy. Soc.*, A., 195.

Feeding Mechanisms of *Chironomus* Larvæ

THE large, hæmoglobin-bearing larvæ of the genus *Chironomus*, commonly known as bloodworms, are the most abundant and widespread members of the bottom mud communities in ponds and lakes, but owing to the obscurity of the medium in which they live little is known about their behaviour. The larvæ live in U-shaped tubes through which an intermittent irrigation current is maintained[1], and are stated to feed on the organic mud around them, eating part of the walls of their burrows or feeding off the surface of the mud[2]. Alsterberg[3], however, considered them to be largely plankton feeders, eating algæ brought in by the irrigation current and trapped by the tube walls or the spines of the anterior proleg. But details of their feeding mechanism or respiratory behaviour are unknown. Accordingly, I have watched the behaviour of larvæ of *Chironomus plumosus* L. under various conditions.

Glass U-tubes, resembling in proportions those which the larvæ construct in Nature, and perforating a small celluloid platform holding a thin layer of mud (Fig. 1), housed the larvæ. Platform and tubes were placed in water in small glass aquaria. In the course of the observations a feeding method was discovered which has not previously been described. The larvæ were seen to feed largely on suspended matter filtered out of a stream of water set up through the tube by their own activity. This feeding is carried out as follows. Maintaining its position in the tube by means of firmly anchored posterior prolegs, the larva performs a number of rotatory movements of the anterior region of the body, the head describing complete circles of alternating direction round the wall of the tube. While these movements are being made the anterior proleg draws out strands of salivary secretion by rapid approach to, and withdrawal from, the mouthparts, the strands being attached to the walls of the tube and stretched across its lumen to form a loose, saucer-shaped sheet. The larva then withdraws a few millimetres down the tube, dragging with it a salivary thread from the middle of the sheet, which is thus pulled out to form a shallow conical net (Fig. 2). Attached to the thread with its mouthparts, it begins violent antero-posterior

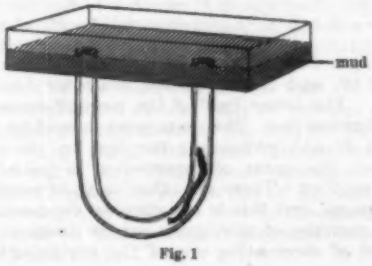

Fig. 1

Fig. 2

undulations of the body with a frequency of about two per second. These have the effect of producing a current of water through the tube, and particles suspended in the water are caught by the conical net. The larva next straightens its body and rapidly eats the cone with the suspended matter on it; it then at once spins another web. The whole process is remarkably rapid, successive cones being formed and eaten at the rate of one every 1½–2 min. Approximately half the time is spent in undulating and the other half in eating and making the net. Although these time intervals vary for individual larvæ their repetition is very regular, and the whole performance forms a very stereotyped behaviour pattern which may persist for an hour or more with a regularity uninfluenced by the degree of loading of the net. More rarely, larvæ omit the net-spinning process and, instead, between the periods of irrigation, scrape the walls of their tubes which, being lined with salivary secretion, also trap particles. Very occasionally they feed from the mud surface; in doing this, they extend the body out of the tube entrance, retaining contact with it by means of the posterior prolegs, and spread a net of salivary secretion over the mud, which is then dragged down with its attached particles for consumption in the seclusion of the tube.

The filtering method is, however, the commonest feeding mechanism in *C. plumosus* and resembles that of leaf-mining chironomids[3,4], except that in the latter the larva turns round after spinning the salivary cone, which is therefore posterior to the larva with the apex pointing away from the body. It also recalls the feeding mechanism of *Urechis caupo*, in which a long cone is secreted by the echiuroid worm and remains attached to the head during the irrigation of the U-shaped burrow[5]. In this case the cone is of mucus with pores of ultramicroscopic diameter and consequently high filtering efficiency[6].

I estimated the filtering powers of the nets of *Chironomus* by introducing into the inhalant current a suspension of carmine, and measuring the diameter of the particles before and after passing through the tube. The nets retain all particles bigger than 17 μ in diameter and most of those bigger than 12 μ in diameter, and would thus trap many planktonic organisms in addition to any particles of detritus, etc., temporarily suspended in the water as a result of agitation of the mud surface. The larvæ are unselective feeders in that they eat indiscriminately all particles attached to the net.

The observations have so far been confined to the larvæ of *Chironomus plumosus*, but it is likely that the other closely related species have the same habits. These larvæ provide one more example of a semi-sedentary animal solving the feeding problem by means of a filter mechanism.

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NUCLEAR MAGNETIC RELAXATION

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THE method of nuclear paramagnetic resonance absorption[1] has been used to study the interaction of nuclei in solids, liquids, and gases with their environment. The two important quantities are the relaxation time T_1, describing the energy transfer from the nuclear spin system to the whole of the sample, representing the heat reservoir, and the interaction among the nuclei alone, which can be described by a spin-spin relaxation time T_2. From the theory of Waller[2] one can predict the relaxation time T_1 caused by interaction of the nuclei with the lattice vibrations. The time obtained is at least 10^4 times larger than the experimental values[3,4,5].

We shall show that another process, occurring in many substances, provides a 'local field spectrum'[6] intense enough to account for the observed relaxation times. Every nucleus experiences not only the constant field H_0, and the applied radio-frequency signal H_1 perpendicular to H_0, but also the local field produced by neighbouring nuclear moments and sometimes by small moments caused by molecular rotation, or in paramagnetic substances by large electronic moments. In liquids and gases, at least, the carriers of these neighbouring moments are not stationary but execute Brownian motion, changing position relative to the nucleus under consideration in a random fashion. Consequently, the local field $H(t)$ will be a random function with a correlation time τ_c, in which the relative position of the neighbours changes significantly. The intensity in the Fourier spectrum of a random function[6] is nearly constant for frequencies $\nu \ll 1/\tau_c$, and falls off rapidly for $\nu \gg 1/\tau_c$. If we assume the correlation function to be of the form,

$$\overline{H(t)H(t+\tau)} = \overline{H^2(t)}\, e^{-t/\tau_c},$$

we obtain for the intensity,

$$H^2(\nu)\Delta\nu = 4\overline{H^2(t)}\,\frac{\tau_c}{1+4\pi^2\nu^2\tau_c^2}\,\Delta\nu.$$

Now components of this spectrum perpendicular to H_0 at the Larmor frequency ($\nu_0 = 2\mu H_0/h$) of the nuclei will induce transitions just as does the applied radio-frequency signal. The transition probability for this process is (for spin $I = \frac{1}{2}$)

$$W = \frac{\mu^2}{4\hbar^2}\, H^2(\nu_0).$$

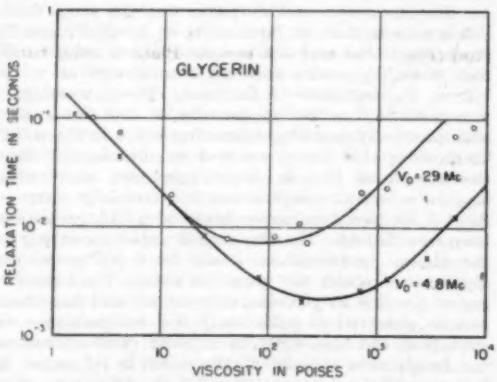
This process provides an interaction between nuclear spins and thermal motion with a relaxation time

$$T_1 = \frac{1}{2W} = \frac{\hbar^2}{\mu^2}\,\frac{1+4\pi^2\nu^2\tau_c^2}{\tau_c}\,\frac{1}{\overline{H^2(t)}}. \qquad (1)$$

$\overline{H^2(t)}$ could, in principle, be calculated for each substance, but will always be of the order $(\mu/r^3)^2$, where μ is the value of the neighbouring moment and r the internuclear distance. The correlation time τ_c can be estimated roughly, as in Debye's theory[7] of polar liquids, from the viscosity and the molecular dimensions. It is perhaps just as accurate in some cases to adopt the experimentally measured Debye time for reorientation of molecules under the influence of Brownian motion, although we must note that in the motion here discussed the neighbours of a molecule as well as the molecule itself are involved. A more refined theory would provide an appropriate distribution of relaxation times. In any event, we expect τ_c to be proportional to the viscosity. We now distinguish two cases: (*A*) $\tau_c \ll 1/\nu_0$, (*B*) $\tau_c \gg 1/\nu_0$. We see from (1) that in case (*A*) T_1 is inversely proportional to the viscosity. In case (*B*) T_1 is directly proportional to the viscosity. In most liquids we have case (*A*). The Debye relaxation in water, for example, occurs in 3×10^{-11} sec. at 20° C. Taking this as τ_c, we obtain with $\nu_0 = 29$ Mc./sec. a nuclear relaxation time of 5 sec., whereas the value of T_1 found in our experiments is 1·5 sec.

The relaxation time is measured by a saturation procedure. The power absorbed by the nuclei relative to the incident power is proportional to the surplus number of nuclei in the state of lower energy. This surplus will fall off rather abruptly if the incident power is increased sufficiently to raise the temperature of the system of nuclear spins.

The relaxation time in ethyl alcohol has been measured at 29 Mc./sec. and 4·8 Mc./sec., between + 60° C. and − 30° C. T_1 is found to be inversely proportional to the viscosity and independent of frequency (case *A*). The accompanying graph shows the relaxation time in glycerin for the same two frequencies and in the same temperature range. It displays all the features predicted by the theory, and shows the transition from case (*A*) to case (*B*). The minimum occurs for $\tau_c = 1/2\pi\nu_0$.



NUCLEAR MAGNETIC RELAXATION TIME T_1 FOR PROTONS IN GLYCERINE

Similar considerations seem to hold for some solids, in which the molecules still have, to some extent, a rotational degree of freedom. This is the case in ice, which also shows a dielectric dispersion. The relaxation time in ice has been measured from −2° C. (0·8 sec.) to −40° C. (20 sec.) at 29 Mc./sec., and is proportional to the Debye time τ_c, obtained from electric dispersion data. It is of the same order of magnitude as in water, but for a different reason, as we are on the other side of the minimum. Although Debye's theory is only concerned with polar molecules, it is clear that τ_c can be defined in a similar way for non-polar liquids. Measurements on a series of hydrocarbons from petroleum ether to heavy mineral oil show a decrease of the relaxation time from 2 sec. to 0·005 sec. with increasing viscosity. The local field $H(t)$ can be greatly enhanced by

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addition of a paramagnetic substance, resulting in a corresponding decrease in relaxation time. Data have been obtained for solutions containing Fe^{+++}, Cu^{++}, Er^{+++} in concentrations from 0·0002 to 0·5 mol. The relaxation time is inversely proportional to the concentration and, roughly, to the square of the magnetic moment of the ion. For F^{19} and Li^{7} resonances in liquids results have been found similar to those for protons. Furthermore, the deuteron resonance has been observed at 4·8 mc. in a water sample containing 50 per cent deuterium. The relaxation time for D in this sample is 0·1 sec. Although the deuteron has a much smaller magnetic moment than the proton, this time is twenty times shorter than that for protons in the same sample, and must be ascribed almost entirely to the action of the quadrupole moment. One can repeat the above calculations for the electric quadrupole transitions by considering the 'local field spectrum' of the tensor grad E. With the known value of the quadrupole moment, one obtains the experimental value of the relaxation time for a reasonable value of grad E in the polar liquid.

Finally, we must consider the spin-spin relaxation time and the closely related problem of the line width. In the limiting case of a solid in which the motion of molecules is very small, the line width can be calculated on the basis that the nuclei are at rest[8], and spin-spin relaxation is produced by the fact that neighbouring nuclei precessing with the Larmor frequency can exchange their energy. On the other hand, in a liquid like water, this exchange will be much smaller, since the rapid Brownian motion smears out the spectrum and averages out the local field. We conclude that in liquids ($\tau_c \ll 1/\nu_0$), T_1 and T_2 are proportional and of the same order of magnitude. But while T_1 passes through a minimum at $\tau_c = 1/2\pi\nu_0$, T_2 continues to decrease. The line width is a monotonic function of viscosity, at first linear, and asymptotically reaching a limiting value in the solid. Confirming this view, we find experimentally that the resonance line in water, glycerin, and other liquids at room temperature is extremely narrow. At 4·8 Mc./sec., an upper limit of 0·015 gauss has been established. The theoretical value according to the above considerations would be 0·007 gauss for glycerin and about 10^{-4} gauss for water. The broadening of the line in glycerin, mineral oil and ice, which can be observed at sufficiently low temperatures, is such that the line width is initially proportional to τ_c. In glycerin at $-30°$ C. the width is 1·5 gauss, in ice at $-5°$ C., 5 gauss, at $-30°$ C., 15 gauss. The line width in solutions of ferric nitrate is proportional to the concentration of the paramagnetic ion, and is 0·6 gauss in a 0·5 mol. solution with a relaxation time $T_1 = 3 \times 10^{-4}$ sec.

A detailed account of this investigation will be sent to the *Physical Review* and will appear in a thesis to be submitted by one of us (N. B.) at the University of Leyden.

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STATE LABORATORY FOR EXPERIMENTAL BIOLOGY AND MEDICINE, NOVI SAD, YUGOSLAVIA

By Dr. PETAR N. MARTINOVITCH
Director

WHILE fighting was still going on in the Pannonian plains north-west of Beograd in 1944, a small group of young medical men and medical students (most of them in uniform) was busy collecting material left behind by the Germans, destined to become the nucleus of the present Laboratory for Experimental Biology and Medicine at Novi Sad, Yugoslavia. In due course they called on me to tell me that they wanted a laboratory for biomedical research. A site for the laboratory was yet to be found. Eventually, a deserted villa on the outskirts of the town was selected; but it was in an appalling condition, and many months of work were necessary to make it suitable for our purpose.

The United Nations Relief and Rehabilitation Administration sent a large amount of laboratory material to Yugoslavia; but it had to be shared by many laboratories and much of it was assigned to field work. Some valuable items, however, were allotted to our institute. Finally, due credit should be given to the progressive citizens of Novi Sad, who spared no effort to help the new laboratory. To-day the Laboratory is a State institution, and the authorities are giving ample credits for its support.

The available space in the Laboratory consists of four large rooms and six smaller ones. One room has been fitted for tissue culture work, and in the cellar there are a workshop, a washing room and a room where experimental animals can be kept. The building stands in a small park, and at the back is a garden with an enclosed space for poultry. The Laboratory is equipped with essential apparatus, instruments and a fair amount of glassware and necessary chemicals; all the equipment of my tissue-culture laboratory at Beograd was transferred to Novi Sad. The Laboratory owns eight hectares of arable land, where the animals are kept and the animal food grown.

Although the official status of the Laboratory was established in May 1946, experimental work did not begin until several months later.

The new Laboratory is being organised on a modest scale along the lines of the Strangeways Research Laboratory at Cambridge. No separate departments are planned and no programme of 'division of labour' on the research level will be attempted. Each laboratory unit will be developed around the man and the field in which he is most interested. Collaboration will be encouraged whenever necessary. No attempt will be made to encourage the Laboratory to grow beyond a certain definite size.

The Laboratory has four objectives, as follows: to bring under the same roof workers engaged in various fields of experimental biology and medical research; to establish the closest possible contacts with laboratories in other lands engaged in the same kind of work; to give an opportunity to promising young people interested in biomedical research to obtain elementary instruction in research methods, in order that they may be sent abroad sufficiently trained for advanced work; to 'popularize' bio-

logical science by publishing books and articles on recent advances made in this field of research.

At present there are only two of us working in the Laboratory, a young doctor of medicine and myself. We are expecting a third, a bacteriologist, to come from the United States, where he has been sent by the Rockefeller Foundation for special training. There are also several young men, now university students, whom the Laboratory hopes eventually to appoint to its staff. The problems at present being studied deal with the morphogenesis of the mammalian gonad, primarily of the germ cells, and with the gonadotrophic function of the pituitary gland.

The long years of war and occupation were a heavy blow to science in Yugoslavia. All research work was brought to a standstill. Completely shut off from the rest of the world, lacking even the most essential equipment for carrying on research, the small number of Yugoslav biologists, even if left alone by the enemy authorities (some were killed or imprisoned), were obliged to struggle for the bare necessities of life for themselves and their families. Since the War has ended, great efforts have been made to pick up the broken threads. But even now there are many obstacles. There is a shortage of almost every article essential to a research laboratory, great difficulties are encountered in replenishing depleted stocks, and reserve parts of precision apparatus are hard to get. Trained laboratory technicians are few, and so are electricians and mechanics acquainted with laboratory apparatus. We are also in dire need of technical books, journals and reprints of scientific papers. We would welcome reprints covering every field of biology and medicine, and the Laboratory at Novi Sad will be glad to forward them where they are most needed.

THE CHEMICAL SOCIETY'S CENTENARY EXHIBITION

THE exhibition at the Science Museum, arranged as part of the centenary celebrations of the Chemical Society, was a memorable one. For the first time, through the co-operation of the director of the Museum, Dr. H. Shaw, a comprehensive display of exhibits illustrating the progress of chemistry in Britain over the past hundred years was housed under one roof.

The exhibition, organised on behalf of the Chemical Society and the XIth International Congress of Pure and Applied Chemistry, by a committee under the chairmanship of Sir Robert Robertson, was divided into two parts, illustrating the history and the everyday uses of chemistry. The historical side was arranged under ten headings each dealing with a section of the subject. Each section has been in the care of a panel of experts responsible for the selection of the exhibits, and for the corresponding chapter of the handbook to the exhibition. This handbook, "Chemical Progress" (London: H.M. Stationery Office. 1*s.* 6*d.* net), is a brief yet comprehensive survey of the British contribution to the science, which future students of chemistry may consult as a historical guide. The chairmen of the panels were Dr. A. E. Alexander, Dr. G. M. Bennett, Prof. J. D. Bernal, Prof. H. V. A. Briscoe, Dr. E. M. Crowther, Prof. C. W. Davies, Prof. D. H. Hey, Prof. C. N. Hinshelwood, Prof. E. K. Rideal, Prof. N. V. Sidgwick and Prof. M. W. Travers. The reports have been edited by Dr. F. Sherwood Taylor, curator of the Museum of the History of Science, Oxford.

A modern section dealing in a popular manner with "Chemistry in Everyday Life" was prepared by the Department of Scientific and Industrial Research, with the co-operation of the Agricultural Research Council, several research associations, and a number of industrial firms. The Central Office of Information prepared the layout of this part of the exhibition, which surveyed such fields as agriculture and food, health, homes and building, fuels, oil, transport and engineering. A popular account of this side was written by Dr. J. P. Lawrie, and this forms the second section of the handbook.

The exhibition was opened on July 14 by the president of the Chemical Society, Prof. C. N. Hinshelwood. The Minister of Education, Mr. George Tomlinson, was in the chair and welcomed the visitors. Prof. Hinshelwood in his opening speech said that the real adventures of science took place in the minds of men, and that much of the exhibition's interest would rely on the association of the objects to be seen with the men who used them.

It is impossible to do justice in the space of a short article to the many exhibits. In each branch of the subject the development was traced from the early pioneers. It was Faraday whose genius laid the foundations of so much of modern chemistry. His work on the alloys of steel was illustrated, as was that on the liquefaction of gases, the forerunner of all later researches in this field. His discovery of benzene was the start of modern organic chemistry, which was illustrated in all its aspects. His work on electrolysis has produced the modern science of electrochemistry, and the use of platinum as a catalyst. The visitor could also see, side by side with their more modern counterparts and developments, his samples of optical glass and colloidal gold.

Graham, too, the first president of the Chemical Society, was a pioneer whose experiments with simple apparatus led to the enunciation of the laws of diffusion in gases and liquids, and to the foundation of modern colloid science. The study of chemical reactions has increased our knowledge of molecular properties and brought about such material advances as photography and plastics. The early theories of valency and atomic structure put forward by Newlands and Crookes were demonstrated. These pointed the way for Mendeléeff, and also for Moseley, whose apparatus and ferrocyanide crystal were exhibited. In the range of inorganic chemistry the fundamental work of Dalton was illustrated by his diagrams of molecular structure. Near this were shown such diverse subjects as glass, precious metals, fluorine chemistry and fluorescent lighting, all items in which British chemists have played a decisive part.

The study of crystallography was represented by a large number of structural models and apparatus illustrating the development of theory and technique in this subject.

The important subject of agricultural chemistry, in which the early work of Lawes and Gilbert at Rothamsted pointed the way to modern scientific methods of increasing the fertility of the soil, was also given prominence.

It is, however, the organic chemist whose work offers the biggest variety of subjects. Each was illustrated by charts and specimens to show the structure, historical synthesis and applications of the substance. Individual exhibits showed early work in carbohydrates at St. Andrews and at Birmingham.

The development of synthetic dyestuffs and fibres was well represented, and space was given, to name a few examples, to synthetic drugs and chemotherapeutic substances including penicillin, and to British work on the vitamins.

The historical part of the exhibition was concluded by a small exhibit of British developments in analytical chemistry.

Space forbids a description of the attractive section on "Chemistry in Everyday Life", which explained in simple terms, by means of a series of illuminated screens and diagrams, the operations and processes by which the raw materials of the laboratory are turned into finished products.

It must be regretted that a historical exhibition on this scale cannot take a permanent place in the national collections, and it is to be hoped that when the Science Museum eventually obtains its long-needed extensions, an enlarged collection, on the lines of the exhibition which has just closed, may be reassembled.

Fig. 2. THE *tgα*-COEFFICIENTS OF TEMPERATURE, CROP AND GROWTH (PINE) SERIES 1890–1939 ON AN EXAGGERATED SCALE. THE TERM 'CEREALS' IS THE AVERAGE OF THE CROP SERIES IN THE TABLE

CLIMATIC FLUCTUATIONS AND VEGETATION GROWTH IN NORTHERN FINLAND DURING 1890–1939

FIG. 1 shows the annual variations in the growth in diameter of pine (*Pinus silvestris* L.) near the timber line in the extreme north of Finland, at about lat. 69° 30′–70° N. The diagram is based on two series of figures[1]: (*a*) represents the weighted average of 148 increment cores collected in July 1939 and 1940; (*b*) represents the average of 58 increment cores collected in July 1945.

The diagram shows the great variation from year to year in the production of organic matter, in this case cellulose. We observe, moreover, an obvious 'low' period of growth during 1901–16, and the gradually increasing growth during the 1920's.

The timber-line forest is very susceptible to the smallest changes in climate (cf. the general statements by Griggs[2] and by Hustich[3]). Thus Fig. 1 may perhaps illustrate to some extent the general influence on growth in the northern part of the Eurasian coniferous zone of the most recent climatic changes. The names on the diagram are those of scientific workers who have expressed an opinion about the regression or progression of the timber-line. The signs − or + indicate that the author mentioned believed it to be receding or advancing respectively. Their opinions are reasonably well explained when considered in connexion with this cyclical growth curve. We can easily understand, for example, why Renvall[4], who worked in the 'low' period, demanded rigorous protection of the timber-line forest because of the "regression of the timber line"; and just as readily we understand why Eide[5], who worked in the 'good' period, was of quite another opinion. I think that the work of Russian scientific investigators on this subject during the same period would give a similar result. The 'low' period is also evident from the occurrence of seed years; there was no important seed year during the 'low' period, shown in Fig. 1, in the northernmost pine forests of Finland.

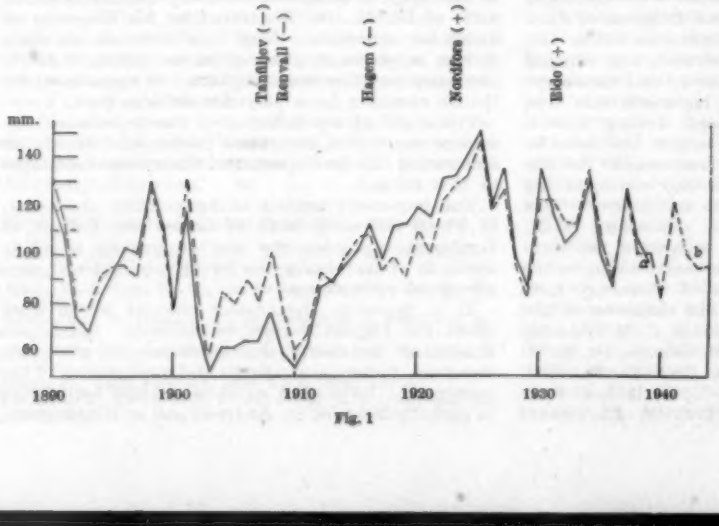

Fig. 1

The same cyclical variation in the production of organic matter also appears in the crop variations of rye, barley, oats and potatoes in northern Finland. The positive trend or 'progression' in the period 1890–1939 is still more pronounced. The positive influence of the climatic improvement of the 1920's was, so far as cereals are concerned, over-accentuated by the improvement in cultivation methods in Finland in recent decades, and by the introduction of better varieties of the various cereals.

In the accompanying table some information is given on the trend (the *tgx* coefficient of the series during 1890–1939) of some temperature indicators, and also of some crop-yield series and growth-series of pine (curve *a* in Fig. 1). The influence of precipitation on growth in the far north is, as is known, of minor significance.

We find that the June temperature shows a slight negative trend, but the July temperature, and especially the August temperature,

increased appreciably during the period 1890–1939 (see Fig. 2). Moreover, the positive trend in the growth in diameter of pine is slightly higher than that of any climatic indicator, thus showing that even a fairly small increase in temperature may result in much accentuated growth[1]. The improvement in the cereal crop has been commented on above. Thus the table and Fig. 2 together give an idea of the general climatic influence on growth phenomena and on the production of organic matter during the period 1890–1939. (There are great annual variations not only in the quantity but also in the quality of the organic matter produced; for example, the annual variation in the amount of potatoes is not correlated with the variation in the percentage of starch of the crop.)

REGRESSION (*tgα*), STANDARD DEVIATION (σ) AND VARIATION COEFFICIENT (% σ/M) IN TEMPERATURE, CROP AND PINE GROWTH-SERIES IN NORTHERN FINLAND

Series (1890–1939)	M	*tgα*	σ	% σ/M
June temperature at 65° N.	12·8° C.	−0·014	1·7	13·7
July temperature "	16·5° C.	0·025	1·9	11·5
August temperature "	13·9° C.	0·051	1·7	8·9
Rye, relative crop values	7·2	0·106	2·2	30·3
Barley " " "	5·3	0·115	1·6	31·4
Oats " " "	5·1	0·078	1·6	30·2
Potatoes " " "	6·9	0·121	2·3	33·0
Pine growth (in $\frac{1}{100}$ mm.)	99·6	0·068	2·6	25·7

In the table the variation coefficients (% σ/M) for the series used are also given. Note the high ratio of the annual variation, especially in the crop series, showing clearly the uncertainty of agriculture in northern Finland (north of lat. 65° N.).

The variation coefficient, or as I would prefer to call it, the 'climatic hazard coefficient', decreases when moving south, being only about 11 per cent for the crops in southern Finland.

In forestry the same phenomenon, namely, increased variability in growth towards the north, can be noticed. The growth measurements made during the second national forest survey of Finland during 1936–38 show that the 'climatic hazard coefficient' for pine is about 23 per cent in northern Finland and about 18 per cent in southern Finland, the corresponding figures for spruce being somewhat lower, namely, 20 per cent and 15 per cent, respectively. This increasing 'variation coefficient' or 'climatic hazard coefficient' from south to north which I have demonstrated corresponds fairly well with the idea that the 'improvement' in recent decades has been most evident in northern countries. It would be of interest to receive information from other parts of the coniferous zone concerning this subject.

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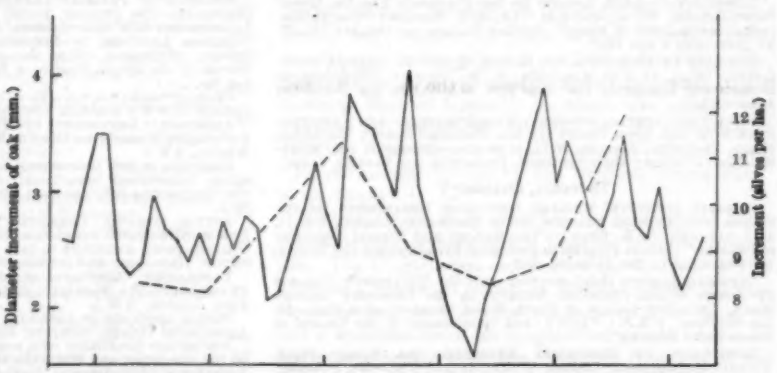
[5] Eide, E., *Medd. Norske Skogsfors. vesen*, 3 (Oslo, 1932).

It seems probable that the fluctuations in plant growth in northern Scandinavia to which Dr. Hustich directs attention are examples of a general phenomenon which will prove to be traceable over the whole of the North Temperate region. Two further examples are shown in the accompanying figure. The first curve represents the mean diameter increment of eight old trees of oak (*Quercus sessiliflora* Sals.) growing in unenclosed woodland near Brook in the New Forest, Hampshire, England. Exactly the same trend is shown by rather younger oak (about two hundred years old) in adjacent enclosures, and by pedunculate oak (*Q. robur* L.) in other parts of the New Forest. The second curve represents the volume increment of mixed silver fir–spruce forest in the Swiss Jura[1], in silves per hectare, between successive enumerations made at intervals of approximately five years. (A 'silvo' is a volume of one cubic metre estimated from the diameter of the trunk and the known average diameter–volume relationship.)

Both these curves show unmistakably the tendency to rise from about 1890 until about 1930, but whereas, according to Hustich, the Finnish curves are unaffected by rainfall, the upward trend of the Swiss and English curves is interrupted by severe depressions associated with the dry periods culminating in 1921 and 1935. The fall in growth from 1930 onwards is shown both in Finland and in England, and it has continued throughout the wetter period which followed 1935, so that it may be associated with a fall in temperature—a possibility



FULL LINE, MEAN DIAMETER INCREMENT OF OAK, NEW FOREST. BROKEN LINE, VOLUME INCREMENT OF SILVER-FIR–SPRUCE FOREST IN SWISS JURA

which is suggested by the temperature curves for Switzerland published by Favre; these curves show quite clearly the general rise in temperature from about 1890 up to 1930.

The rise in temperature over this period has apparently also been demonstrated in America[2], and it accords with much that is known concerning the behaviour of glaciers and ice-caps.

It seems clear that the investigation of the trends of growth shown by trees over long periods, as distinct from the attempts to interpret the peculiarities of individual rings, is a very promising field of work.

E. W. JONES

Imperial Forestry Institute,
Oxford.

[1] For the Forest of Couvet; from Favre, E., *Schweiz. Z. Forstw.*, **95**, 161 (1944).
[2] Kincer, J. B., *Biol. Abst.*, **27**, No. 16763 (1946).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, October 4

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St. James's Park, London, S.W.1), at 3 p.m.—Discussion on "A Survey of Combustion Research as applied to the Internal Combustion Engine" (to be opened by Mr. N. P. W. Moore).

Monday, October 6

SOCIETY OF ENGINEERS (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. C. D. Mitchell: "Prefabricated Pre-Cast Concrete Structures, including Floating Craft".

SOCIETY OF CHEMICAL INDUSTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. J. W. Walker: "Synthetic Drugs in the Fight against Tropical Diseases".

Tuesday, October 7

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 2.30 p.m.—Brigadier A. E. Richmond: "Positive Health—its Attainment in the Soldier, and the Army's Contribution to it in the Civilian".*

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS, LONDON CENTRE (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. J. Neale and Mr. W. E. Adams: "Some Recent Developments in the Design of Short Wave Receiving Stations".

UNIVERSITY COLLEGE, LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5.15 p.m.—Prof. J. Z. Young, F.R.S.: "The Structure of Peripheral Nerve and of Nerve Endings" (further lecture on October 14).*

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (in the Rooms of the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. D. R. Hartree, F.R.S.: "Electronic Calculating Machines".

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—First Annual General Meeting of the Division; Mr. S. Markland and Mr. N. Tattersall: "High Speed C.I. Engines".

Wednesday, October 8

UNIVERSITY COLLEGE, LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Dr. M. H. Pirenne: "The Physiological Mechanisms of Vision" (further lectures on October 15, 22, 29, November 5 and 12).*

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. B. B. Morton: "Metallurgical Methods for Combating Corrosion and Abrasion in the Petroleum Industry".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGICAL AND NUTRITION PANELS OF THE FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Discussion on "Microbiological Proteins; their Synthesis, Production and Feeding Value".

Thursday, October 9

IMPERIAL INSTITUTE, MINERAL RESOURCES DEPARTMENT (in the Cinema Hall, Imperial Institute, South Kensington, London, S.W.7), at 3 p.m.—Mr. S. H. Shaw: "The Geology and Mineral Resources of Palestine" (Recent Progress in Geological Investigations and Mineral Developments in the Colonies, 8).*

CHEMICAL SOCIETY (joint meeting with the UNIVERSITY COLLEGE OF NORTH WALES CHEMICAL SOCIETY, in the Chemistry Lecture Room, University College of North Wales, Bangor), at 4 p.m.—Sir Ian Heilbron, F.R.S.: "D.D.T. and Gammexane in the Control of Insect-borne Diseases".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. P. Good: Inaugural Address as President.

ROYAL AERONAUTICAL SOCIETY (in the Lecture Hall of the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. W. M. Widgery: "Pressurisation of Aircraft".

Friday, October 10

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

CHEMICAL SOCIETY (joint meeting with the SOUTHAMPTON UNIVERSITY COLLEGE CHEMICAL SOCIETY, in the Physics Department, University College, Southampton), at 5 p.m.—Prof. C. C. Price: "The Influence of Substituents on the Polarity of the Benzene Ring".

Saturday, October 11—Saturday, November 1

ROYAL PHOTOGRAPHIC SOCIETY (at 16 Prince's Gate, London, S.W.7).—Ninety-second Annual Exhibition. Part 2: Scientific, Nature, Record and Technical.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN MINING, and a LECTURER IN ELECTRICAL ENGINEERING at the Cannock Chase Mining College—The Director of Education, Dept. F.E., County Education Offices, Stafford (October 11).

JUNIOR LABORATORY TECHNICIAN (Grade C)—Dr. M. Reiss, Bristol Mental Hospital, Fishponds, Bristol (October 11).

TEACHER IN THE MATHEMATICS AND PHYSICS DEPARTMENT—The Principal, Municipal Technical College, Hopwood Lane, Halifax (October 11).

ASSISTANT IN AGRICULTURE at the Essex Institute of Agriculture—The Chief Education Officer, County Offices, Chelmsford (October 13).

COUNTY AGRICULTURAL ADVISERS (7), EXPERIMENTAL OFFICERS (2), HORTICULTURAL ADVISERS (2), a HORTICULTURAL INSTRUCTOR, INSTRUCTRESSES (2) IN DAIRYING AND POULTRY-KEEPING, and an APIARIST, for posts in the County Extension Services of the Colleges—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (October 15).

SCIENTISTS (Grade III) for the National Coal Board: a PHYSICAL CHEMIST and PHYSICIST in Greater London for laboratory research into dust problems in mines, Ref. No. F.794/47A, a PHYSICIST for applied research in North Staffs coalfields on problems of firedamp and ventilation in mines, Ref. No. A. 339/47A, a PHYSICIST for laboratory research on underground illumination, Ref. No. A.340/47A, and a MECHANICAL ENGINEER for laboratory research into development of dust control equipment, Ref. No. C.567/47A—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting appropriate Ref. No. (October 18).

SENIOR ASSISTANT IN MECHANICAL ENGINEERING, a RESPONSIBLE LECTURER IN PRODUCTION ENGINEERING, a LECTURER IN ELECTRICAL ENGINEERING, a LECTURER IN SCIENCE SUBJECTS (with either Chemistry or Biology or Metallurgy as a main subject), a LECTURER IN MATHEMATICS, and a LECTURER IN BUILDING SUBJECTS—The Principal, Luton Technical College, Park Square, Luton (October 20).

LECTURERS IN MECHANICAL or ELECTRICAL ENGINEERING in the Cape Technical College, Cape Town—J. A. Ewing and Co. (Ldn.), Ltd., Finsbury Court, Finsbury Pavement, London, E.C.2 (October 20).

RESEARCH ASSISTANTSHIP IN THE NUFFIELD DEPARTMENT OF INDUSTRIAL HEALTH—The Registrar, King's College, Newcastle-upon-Tyne (October 31).

SOIL CONSERVATION OFFICER by the Government of Ceylon for the Department of Agriculture—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18513 (October 31).

LECTURER IN THE MATHEMATICS DEPARTMENT—The Principal, Heriot-Watt College, Edinburgh (October 31).

PRINCIPAL OF THE PADDINGTON TECHNICAL INSTITUTE, Saltram Crescent, W.9—The Education Officer (T.1), County Hall, London, S.E.1 (November 1).

ASSISTANT LECTURER IN MYCOLOGY—The Registrar, The University, Manchester 13 (November 7).

LECTURER IN PSYCHOLOGY at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (November 10).

PHYSICIST or PHYSICAL CHEMIST (preferably with experience in electronics)—The Director, British Launderers' Research Association Laboratories, Hill View Gardens, London, N.W.4 (November 13).

SENIOR LECTURER IN PSYCHOLOGY at the Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (November 14).

CHAIR OF ORIENTAL STUDIES—The Registrar, University of Sydney, Sydney, N.S.W., Australia (November 30).

ASSISTANT IN DEPARTMENT OF CHEMICAL PATHOLOGY—The Chemical Pathologist, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1.

ENGINEER IN THE IONOSPHERE SECTION of the Overseas and Engineering Information Department of the B.B.C., based in London—The Engineering Establishment Officer, Broadcasting House, London, W.1.

JUNIOR ORGANIC CHEMISTS—The Secretary, British Rubber Producers' Research Association, 19 Fenchurch Street, London, E.C.3.

LABORATORY ASSISTANT to take charge of physics laboratory—The Bursar, Haileybury and Imperial Service College, Hertford.

LABORATORY ASSISTANT (Grade I) IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1.

SENIOR LECTURER IN AGRICULTURE—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

BIOCHEMIST (preferably with some experience of research) for work on the separation and properties of macro-molecules—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

A Plan for Science: a Memorandum produced by the Science Advisory Committee of the Communist Party. Pp. 32. (London: Communist Party, 1947.) 6d. [273

Medical Research Council. Special Report Series, No. 259: The Marine Type of Tubercle Bacillus (the Vole Acid-fast Bacillus). By A. G. Wells, with Notes on the Morphology of Infection by the Vole Acid-fast Bacillus, by A. H. T. Robb-Smith. Pp. iv + 48 + 13 plates. (London: H.M. Stationery Office, 1946.) 2s. net. [273

Department of Scientific and Industrial Research: Building Research. Technical Paper No. 29: Weathering Tests on Asbestos-Cement Roofing Materials. By Dr. F. E. Jones. Pp. 28. (London: H.M. Stationery Office, 1947.) 1s. net. [273

Proceedings of the Royal Irish Academy. Vol. 51, Section A. No. 5: The Foundation of the Theory of Probability, I. By Erwin Schrödinger. Pp. 51–66. 1s. 6d. No. 6: Stereographic Projection and the Linear Fractional Group of Transformations of Quaternions. By P. G. Gormley. Pp. 67–86. 2s. 6d. No. 7: Radiation Damping in the General Theory of Relativity. By N. Hu. Pp. 87–112. 3s. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1947.) [313